Scientific Programme Abstracts

Monday 1 June

0800–0850
Scientific Session
Interventional Radiology 1
Hall 1

0800

Catheter-directed venous thrombolysis: an *in vitro* study assessing fluid dispersion from a pulse spray system

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PURPOSE: Pulse spray thrombolysis in acute arterial insufficiency is cited as the optimum method to deliver thrombolytic agent, in terms of total dosage and duration of infusion. The role of catheter-directed venous thrombolysis remains undefined, although interim reports from the Venous Thrombosis Registry of the Society of Cardiovascular and Interventional Radiology indicate a role for such therapy. Both the dose and infusion duration in venous thrombolysis are large compared with arterial thrombolysis. Potential advantages and disadvantages exist regarding the use of pulse spray catheter systems for venous thrombolysis. In particular, long infusion length catheters may reduce both total dose and infusion time, although potential problems exist with such a system. This study evaluates the fluid dispersion characteristics of a pulse spray system. METHODS: A cylindrical frame was constructed to house commercially-available side-slit pulse spray catheters. Paper lined the inner wall of the cylinder. Catheters with infusion lengths of 10, 20 and 30 cm were placed along the axis of the cylinder. Dilute ink was pulsed by a dedicated pulse spray infusion pump through each catheter using pulse volumes of 0.1, 0.2, 0.3, 0.4 and 0.5 ml. RESULTS: The resultant ink patterns reflect the dispersion characteristics of each catheter at each pulse volume. The patterns have been digitized to allow quantitative analysis. As catheter length increases, there is increasing loss of uniformity of fluid dispersion, with decreased volume passing through the distal side slits. CONCLUSION: Longer pulse spray catheters, which may be used for venous thrombolysis, do not provide uniform fluid dispersion *in vitro*. This may have implications *in vivo*.

0810

Use of intravascular ultrasound in stenting for aortic occlusive disease

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Intravascular US (IVUS) allows assessment of endoluminal and vascular wall morphology. The role of IVUS as a tool in the assessment of aortic stent placement and follow-up, for occlusive disease, was investigated. IVUS was carried out using a mechanical rotating head system, with either a 30 MHz Dumed, or a 20 MHz CVIS system. The IVUS catheter was introduced percutaneously by retrograde femoral route prior to imaging. Aortic diameter at, above and below the site of the lesion was measured. Balloon size and endovascular stent were selected on the basis of IVUS measurements and guided under fluoroscopic control to the lesion site. The stent was placed under fluoroscopic control. After placement, the stent was imaged by IVUS. 13 stents were assessed using IVUS (12 Palmaz; one nitinol Memotherm) in nine patients (five male, four female; age range 57–80). All stents were placed for severe symptomatic ischaemia of the lower limbs. Eight stents were imaged at the time of placement and five at follow-up, when patients developed further symptoms of ischaemia. In all cases, following balloon angioplasty under fluoroscopic control, IVUS revealed under-expansion of the stent, requiring further angioplasty. Maximum balloon diameter was 14 mm and stent expansion ranged from 10 mm to 12.9 mm. In cases of symptomatic recurrence, the cause was found to be thrombus formation, stent irregularity and under-expansion. IVUS demonstrates that stent under-expansion is a common phenomenon in large stents placed for aortic occlusive disease. This factor may be significant in recurrent problems following endovascular stenting.

0820

Combined radiological and surgical endovascular remote endarterectomy in femoropopliteal occlusion

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PURPOSE: To evaluate a new, minimally-invasive technique using a ring stripper and Moll ring cutter for the treatment of long femoropopliteal occlusions. TECHNIQUE: The popliteal artery is cannulated using a "smart needle" and the distal end of the occlusion defined. From an arteriotomy in the superior femoral artery, a ring stripper is advanced antegradely in the dissection plane, under radiological control, until the occlusion is passed. A Moll ring cutter is then used to transect the distal intimal core and the occluding core is removed. A guide-wire is passed retrogradely from the popliteal artery to the arteriotomy and a balloon-expandable stent is placed antegradely to "tack" down the distal circumferential intimal flap. The arteriotomy is then extended into the caudal femoral artery and closed with a vein patch to ensure good in-flow. MATERIALS: 17 patients with long femoropopliteal occlusions and patent distal popliteal arteries with at least a one-vessel run-off were treated. All had disabling claudication. RESULTS: The initial success rate was 12 out of 17 patients (71%). All patients were discharged within 24 h. The primary patency rate (at 1–6 months) was 10/17 (59%). Those in whom the procedure failed, underwent femoropopliteal bypass. The longer term results from this on-going trial will be presented. CONCLUSION: The technique is safe and effective. After the learning phase is passed, the initial success rate is high and compares favourably with similar new techniques. Further study of the long-term results is needed.

0830

Outcome of endovascular stenting in arterial occlusive disease

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All vascular stents deployed in this institution have been prospectively followed-up by clinical examination, duplex Doppler US and measurement of ankle-brachial pressure index (ABPI) at 24 h, 6 weeks, 6 months and annually. This study details outcome. Digital subtraction angiography was obtained if indicated by increase in peak systolic velocity of three times on duplex; decrease in ABPI of greater than 0.15 or recurrence of ischaemic symptoms, 54 stents were placed in 48 patients [18 female; 30 male mean (range) age 64 (36–89) years]. Stented vessels included aorta (seven), common iliac artery (25), external iliac artery (16), superficial femoral artery (two) and subclavian artery (four). Indications for stenting were primary occlusions (17); primary stenosis (14); restenosis (15); dissection during angioplasty (three); occlusions post-angioplasty (two) and trauma (two). One stent was successfully redilated after a restenosis detected on duplex. Primary patencies were 94% at 24 h, 92% at 6 weeks, 91% at 6 months and 85% at 1 year. Primary assisted-patency rates were 98% at 24 h, 97% at 6 weeks, 97% at 6 months and 96% at 1 year. 26 stents have been followed up for a year or more. Two patients have died from other causes during follow-up. Complications have included three early and one late thrombosis (three out of four successfully thrombolysed) and one amputation. Early results suggest that endovascular stenting can be undertaken with low morbidity and good patency rates.

0840

Outcome following stenting for aorto–iliac occlusive disease

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AIMS: To review the experience of aorto–iliac metallic stent insertion for occlusive disease over a 3 year period. METHOD: Review over a 3 year period of 30 patients undergoing stent insertion. Eight patients underwent bilateral stenting, giving a total of 38 stented lesions. 22 lesions were treated for claudication, 16 for critical limb ischaemia (10 with rest pain, six with ulcers and two with gangrene). In 22 cases the stent was inserted for complete occlusion, in 15 cases for severe primary stenosis and in one case for re-stenosis. 30 lesions were in the common iliac artery, the remaining eight in the external iliac artery. There were 13 Palmaz, 13 Wallstents, 10 Memotherm and two Symphony stents inserted. RESULTS: 31 of the 36 stents (86%) were patent at a mean follow-up of 12 months (range 1–33

months). Adjunctive procedures were necessary in seven patients: one patient required thrombolysis, one patient had an embolectomy, two patients required percutaneous angioplasty distal to the stent, four patients required infrainguinal vascular by-pass grafts. There were two early stent occlusions, at day 2 and day 7, both in patients with acute limb ischaemia, both these patients required eventual limb amputation (1 AKA, 1 BKA)—one of these patients subsequently died of respiratory failure at day 15, post-bilateral stent insertion, unrelated to the procedure. Two significant groin haematomas were caused. CONCLUSION: Stenting for aorto iliac occlusive disease can be performed with acceptable early complication rates. The early patency rates are encouraging.

0800–0850
Scientific Session
Gastrointestinal Obstruction
Hall 9

0800
Assessment of patterns of large bowel dilatation on plain abdominal X-rays

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PURPOSE: To determine the feasibility of distinguishing between large bowel obstruction and other causes of large bowel dilatation on plain abdominal X-ray, by analysis of the configuration of the distal end of the colonic gas column. METHOD: A series of supine and erect abdominal radiographs were examined retrospectively to analyse the configuration of the distal component of the distended large bowel loop. The degree of dilatation of the descending colon in suspected distal left-sided obstruction was evaluated as an independent feature. Thereafter, the radiographic interpretation was correlated with the cause of large bowel dilatation as determined by barium enema examination, surgical findings or characteristic clinical picture. RESULTS: If the distal end of the column of gas in the distended colon was rounded, then the cause of dilatation was usually an obstructing lesion, such as a carcinoma. If the end of the gas column was "V-shaped", then the dilatation was likely to be due to gaseous distension of a dynamic, non-dependent bowel, such as occurs in ileus or toxic megacolon. The presence or absence of distension of the descending colon was an additional helpful feature. CONCLUSION: Analysis of the configuration of the distal end of the distended colonic gas column may be a helpful guide in determining the need for urgent single contrast barium enema examination in large bowel dilatation on plain abdominal radiographs. A prospective study is planned to further evaluate the validity of these observations.

0810
Water-soluble contrast follow-through examination as a simple diagnostic tool in suspected small bowel obstruction

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PURPOSE: This study was to examine retrospectively the value of non-ionic water-soluble contrast follow-through in predicting the outcome in patients with a clinical diagnosis of small bowel obstruction. MATERIALS AND METHODS: 20 patients, aged 17–87 years (mean = 52 years) with clinical and plain film evidence of small bowel obstruction were studied. A water-soluble contrast follow-through examination using 100 ml of "Gastromira" was carried out. Radiographs were taken at 1, 2 and 4 h. Significant small bowel obstruction was diagnosed if contrast failed to reach the caecum/stoma by 4 h. RESULTS: Of the 20 patients, 11 (55%) were confirmed to have significant small bowel obstruction on the basis of the contrast follow-through study, seven of these patients had surgically confirmed findings as follows: five adhesions, one incarcerated hernia, one disseminated intra-abdominal malignancy. Two patients who had recently undergone abdominal surgery had a presumed clinical diagnosis of post-operative ileus and one patient was considered unfit for surgery. Eight patients (40%) had normal follow-through studies and their symptoms improved without further intervention; seven were discharged, one had a caecal tumour diagnosed on follow-up barium enema. No morbidity was associated with the examination. One patient was noted to have gastric outflow obstruction on the follow-through examination and was subsequently found to have an acute duodenal ulcer. CONCLUSION: The preliminary findings of this ongoing study suggest that a limited water-soluble contrast follow-through examination is safe and useful in selecting patients for surgery in suspected small bowel obstruction.

0820
Distinction between post-operative ileus and small bowel obstruction: the role of CT

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PURPOSE: The purpose of the study was to determine the role of abdominal CT in the distinction of paralytic ileus from mechanical small bowel obstruction (SBO) in the immediate post-operative period and to correlate these findings with those of enteroclysis and plain abdominal radiographs. MATERIALS AND METHODS: A study of 42 post-operative patients with signs of paralytic ileus or mechanical small bowel obstruction was undertaken. All patients were examined clinically and underwent plain abdominal radiograph and CT examination within 24 h. In some cases enteroclysis was performed. All findings were interpreted blindly by two radiologists and statistical analysis was based on paired χ^2 test. The "gold standard" for diagnosis was laparotomy or/and clinical course of the patients. RESULTS: According to our results, CT was effective in distinguishing post-operative paralytic ileus from complete mechanical SBO (sensitivity 94%, specificity 100%), while the combined clinical and plain film findings were often nondiagnostic (sensitivity 29%). CT was also valuable in the diagnosis of partial mechanical SBO (sensitivity 83%) and enteroclysis proved significantly informative in six cases of partial SBO. CONCLUSION: CT has an important role in distinguishing paralytic ileus from complete mechanical SBO in the immediate post-operative period. Partial mechanical SBO may be further investigated using enteroclysis.

0830
CT in the diagnosis and prognosis of adhesive small bowel obstruction

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PURPOSE: To determine the value of CT as a primary diagnostic procedure in the diagnosis and treatment of adhesive small bowel obstruction. METHODS AND MATERIALS: The study group included 137 patients with small bowel obstruction. Patients were consecutively collected over a 30 month period. CT images were interpreted prospectively in consensus by a fellow resident and an experienced gastrointestinal radiologist. Readers were asked to determine the cause of the obstruction and if the obstruction was complicated by strangulation and/or volvulus. CT results were compared with the surgical findings and patient outcome. RESULTS: The diagnosis of adhesive small bowel obstruction was achieved in 85 patients (sensitivity: 97%, specificity: 82%). Volvulus was correctly diagnosed by CT in 13 patients (sensitivity: 81%, specificity: 88%) and strangulation in 17 patients (sensitivity: 100%, specificity: 93%). Complicated obstruction, defined as the presence of a volvulus and/or strangulation, was correctly diagnosed in 19 patients (sensitivity: 86%, specificity: 87%). Negative predictive value of CT for volvulus, strangulation and complicated small bowel obstruction were respectively 95%, 100% and 95%. CONCLUSION: Based on its high negative predictive value, CT should play a major role in the choice between medical or surgical treatment.

0840
CT diagnosis of strangulating obstruction of the small bowel

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PURPOSE: To report the CT signs of strangulation in patients with high grade small bowel obstruction. MATERIAL AND METHODS: We collected the CT files of all patients who had a diagnosis of strangulation confirmed at surgery over a 24 month period. This group of 17 patients was compared with a control group of 64 patients with non-complicated small bowel obstruction. The presence of the following features was assessed in a prospective manner in both groups: mural thickening, target sign, reduced mural enhancement, mesenteric congestion, mesenteric fluid, ascitis. The diagnosis of strangulation was affirmed in the presence of reduced

enhancement of the bowel wall, or two of the other signs. The CT signs were correlated with the surgical findings. Laparatomy was carried out in 36 patients because of failure of the medical treatment ($n=15$), or presence of clinical and/or radiological signs of complications ($n=21$). RESULTS: CT affirmed or suspected a strangulation in 23 patients. Strangulation was confirmed at laparotomy in 17 patients and there were no false negative examinations (sensitivity = 100%, specificity = 93%). Abnormal enhancement was present in 5/15 patients in the strangulation group, 0/64 patients in the control group; the triad of mural thickening + mesenteric fluid + mesenteric congestion in 5/15 and 2/64 patients; ascitis in 16/17 and 15/64 patients, respectively. CONCLUSION: Reduced enhancement of the bowel wall and the triad of mural thickening + mesenteric fluid + mesenteric congestion are highly suggestive of strangulation and should prompt rapid surgery.

0800–0850
Refresher Course
Shoulder Imaging
Hall 11a

0800
Invited Review
MRI shoulder pain and instability
P M Hughes
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Instability of the shoulder can be multifactorial and result in recurrent subluxation or dislocation. The function of imaging is to identify the direction of the instability and to identify causative abnormalities. The presentation will address the pathogenesis and investigation of shoulder instability and the relevance of specific findings to surgical management. CT, MRI and MR arthrography (MRA) are the main techniques used to investigate instability. The strengths and weaknesses of these techniques will be discussed, but there are four main review areas: (i) humeral head, (ii) capsule, (iii) labrum, (iv) glenohumeral ligaments. The Hill–Sachs lesion in the humeral head is indicative of previous dislocation, its site indicates the direction of dislocation. The capsule may insert at the base of the labrum (Type 1), medial to the labrum on the neck of the glenoid (Type 2), or more than 2 cm medial to the glenoid rim (Type 3). The Type 3 configuration may represent either anterior stripping due to previous dislocation or a congenital variant, but both may predispose to recurrent anterior instability. In isolation from labral and ligamentous abnormalities, however, this is unlikely to lead to instability. The labrum has a varied appearance (triangular, ovoid, flattened or absent). Detachment of the antero–inferior aspect of the labrum (Bankart lesion) renders the inferior labro–ligamentous complex ineffective. Glenohumeral ligaments: the inferior ligament is the largest and most important, its integrity and attachment to the gleno–labral margin are essential to stability. Distinctive lesions, such as the anterior labrum periosteal sleeve avulsion (ALPSA) and gleno-labral ovoid mass (GLOM) lesions, will be demonstrated.

0825
Invited Review
Rotator cuff disease
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MRI has gained acceptance as a non-invasive technique in the assessment of patients with shoulder dysfunction, related to its ability to demonstrate normal complex anatomy and detect subtle soft-tissue and bone changes. For complete assessment of the soft-tissue and osseous structures around the shoulder, imaging in three planes using a variety of pulse sequences is required. The main stay for the diagnosis of a rotator cuff tear is the coronal-oblique T_2 weighted fast/turbo spin echo with fat suppression (or STIR), aligned along the line of the supraspinatus tendon. Rotator cuff disease with impingement is one of the most prevalent disabling conditions of the shoulder. The aetiological factors in rotator cuff tear include ageing, acute trauma (in an already compromised tendon), over-use, impingement and chronic inflammatory disease. There is a continuum from normal to varying degrees of degeneration (tendinopathy), leading to frank tears producing a variety of signal intensity patterns that can be differentiated within the rotator cuff tendons. Rotator cuff tears are classified into partial on the bursa or articular surface of the tendon, full thickness and complete. The majority of the tears occur on the articular surface adjacent to the tendon insertion on the greater tuberosity. The accuracy in the diagnosis of partial and full thickness rotator cuff tears is 90–95%, although there can be difficulty in differentiating a partial tear from tendinopathy. A number of pitfalls (*e.g.* the anterior interval and the magic angle effect) that mimic rotator cuff disease need also to be recognized. Impingement syndrome is a combination of clinical signs and symptoms, produced as a result of compression of the coracoacromial arch on the contents of the subacromial space. This is principally a clinical diagnosis, with a positive response to an injection of local anaesthetic into the subacromial space. The clinical diagnosis of impingement syndrome is, however, often difficult. MRI can be helpful in defining the anatomy and assessing those at risk of developing impingement syndrome. Anterior acromial impingement is the most common type. It should be noted that an individual with anatomical configuration predisposing to impingement may not develop symptoms unless the shoulder undergoes repetitive/stressful activities. Equally, professional athletes may develop symptoms with normal anatomy, apart from over-development of the rotator cuff muscles.

0800–0850
Refresher Course
How to Set Up and Run an Echo Service
Hall 11b

0800
Invited Review
Echocardiography in a cardiothoracic centre
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Echocardiography is an extremely valuable technique in the diagnosis and management of patients with cardiac disease. The number of echocardiograms performed over the past few years has increased dramatically, due to the rapid advancement in US technology and the ever-widening indications for echocardiography. This has caused increased pressure on echocardiography departments, similar to that experienced by many radiology departments, in a time of limited resources and staff. This paper will concentrate on the role of echocardiography in a cardiothoracic centre and, in particular, the patient population, technician and doctor training and the use of advanced techniques, *e.g.* stress echocardiography and transoesophageal echocardiography. Methods of controlling the service demand will also be considered. The majority of patients referred to a cardiothoracic echocardiography department are already known to have some form of cardiac disease. The percentage of patients with abnormal scans is higher than in a non-specialist centre, necessitating detailed echocardiographic studies in most patients. Some patients are involved in clinical trials with ambitious echocardiographic protocols which, if accepted uncritically, will lead to severe pressure on the service. In some cardiothoracic centres, echocardiography is considered the poor relation of the other more invasive cardiological imaging techniques, leading to poor morale among the staff and difficulty in obtaining adequate resources. Echocardiography is an essential technique in a cardiothoracic centre, but it must be performed to the highest standard, with dedicated staff and equipment to ensure that the results obtained are accurate, reproducible and clinically informative.

0825
Invited Review
Provision of an echocardiography service in a district general hospital
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The provision of echocardiography services varies widely between district general hospitals, both in the facilities used and the personnel involved. A survey undertaken in Scotland (1994) showed that echocardiograms are predominantly performed by medical, rather than technical, staff and many respondents considered training to be inadequate. Nearly a fifth of echocardiograms were performed and reported by radiologists. Radiologists usually have access to suitable US equipment, often with colour Doppler facilities, and use echocardiography as part of an integrated approach to cardiac imaging, along with other imaging modalities, such as MRI, nuclear medicine and the plain chest radiograph. The number of requests for echocardiography has increased considerably over the past few years. The

maintenance of a service to provide for this ever-increasing demand can be a problem, particularly in the smaller hospital, where there may be a sole provider. In our experience a third of all referrals are from the Department of Medicine for the Elderly and these are often for suspected aortic stenosis. The clinical symptoms of this disorder can be non-specific, such as confusion, fatigue and falls and the clinical signs can be unreliable. There has also been a significant increase in the number of requests for assessment of left ventricular function over the past few years, along with the increased use of ACE inhibitors for the treatment of cardiac failure.

0800–0900
Scientific Session
Oncological Imaging
Olympian Suite

0800
How adequately do we stage Hodgkin's disease in the Northern region?

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In 1994 the Royal College of Radiologists issued guidelines on the optimum CT investigation of Hodgkin's disease (HD) and other malignancies. 76% of patients with HD in the Northern region of England are investigated and treated in local hospitals, not at specialist centres. We have reviewed 349 new patients with confirmed HD, presenting in our region 1991–1995. Imaging data was available in 315. Concerning first examinations: 93% received CT scans of the chest (C), abdomen (A) and pelvis (P); and 20% CT neck and 4% CT head. 62% (C) and 65% (A/P) were performed within ±4 weeks of the date of diagnosis (biopsy), whilst 12.5% (C) and 9.9% (A/P) were performed more than 12 weeks after diagnosis (some >40 weeks). 31% (C) and 64% (A/P) sectioning protocols were conducted outside guidelines. In 48% (C) and 90% (A/P) some slice intervals were >20 mm. Only 32% (C) and 35% (A/P) received iv contrast. Images were not viewed on lung settings in 15% (C) or on bone settings in 98% (C) and 99% (A/P). Images were recorded on hard-copy, with variable window width and/or levels in 10% (C) (soft tissues), 4% (C) (lungs) and 27% (A/P) (soft tissues). In patients having at least one follow-up scan, only 48% (C) and 23% (A/P) had all subsequent scans within guidelines. The findings suggest there is scope for improvement in local practice.

0810
The role of MRI in lymphoma

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PURPOSE: To evaluate the diagnostic impact of MRI in Hodgkin's (HD) and non-Hodgkin's lymphoma (NHL). METHOD: 163 MRI examinations (180 areas) in 104 patients with HD and NHL were retrospectively reviewed to determine the major indications for referral and the impact of MRI on patient management. The latter was assessed by studies that had resulted in a positive change in management decision. Reassurance value of investigations was ignored, unless this contributes to alteration in management. RESULTS: Areas examined comprised: brain (five), of which 14 studies (26.9%) were for primary cerebral lymphoma; spine (68); thorax (26); abdomen and pelvis (20); extremities (12); and miscellaneous regions (four), including mandible and brachial plexus. The indications for referral were classified into categories of (i) staging of primary tumour (four); (ii) evaluation of cord compression (38); (iii) evaluation of residual masses (54); (iv) suspected recurrence (56); and (v) characterization of lesions (11). The positive impact of MRI in patient management was found to vary between 100% in group (i) and 27% in group (v) with an overall positive result achieved in 52.7%. CONCLUSION: The impact of MRI on management of patients with lymphoma varies with the clinical indication. Within the group studied, MRI had a positive impact on management decision in 52.7%.

0820
SPIO-enhanced MRI and dual phase helical CT for liver metastases: comparison with AFROC analysis

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PURPOSE: To compare the performance of SPIO-enhanced MRI and dual phase helical CT in the pre-operative detection of hepatic metastases. METHODS: 43 hepatic resection candidates with known colorectal metastases were studied. MRI comprised fast spin echo (TR 4000, TE 91) and T_1 weighted GRE in-phase (TR 156, TE 6, FA 80°) and opposed-phase (TR 135, TE 4, FA 80°) sequences before SPIO and dual echo (TR 2000, TE 45/90), T_2 weighted FLASH (TR 150, TE 10, FA 15°) and T_1 weighted GRE after SPIO. CT comprised 8–10 mm collimation with 1:1 pitch, imaging was commenced 20 and 65–70 s after injection of 150 ml contrast. Four blinded observers recorded the number and location of lesions, assigning each a confidence rating using a four point scale. Results were correlated with surgery, IOUS and histology in 24 patients and with a four panel consensus review, together with all other imaging, in 19 patients. AFROC methodology was used to analyse the results and sensitivities were calculated. RESULTS: 162 lesions (146 malignant, 16 benign) were present, 76 confirmed by surgery and 86 by consensus review. Mean areas under the AFROC curves were 0.82, 0.78 and mean sensitivities 79%, 76% for MRI and CT respectively (no statistically significant statistical difference between the two techniques). However, in the group of patients with surgical confirmation, the mean sensitivity for malignant lesions was significantly better on MRI (79%) than on CT (74%) ($p=0.002$, t test). CONCLUSION: SPIO enhanced MRI is more sensitive than dual phase helical CT in the detection of surgically confirmed colorectal metastases.

0830
Spectroscopy and dynamic contrast enhanced MRI of prostatic carcinoma and benign prostatic hypertrophy

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PURPOSE: Conventional MRI is unable to differentiate reliably prostatic carcinoma from benign prostatic hypertrophy (BPH). This study investigates the use of magnetic resonance spectroscopy (MRS) with dynamic contrast-enhanced MRI to improve the discrimination of prostate pathology. MATERIALS AND METHODS: 16 patients with histologically-confirmed prostatic carcinoma and/or BPH were investigated on a 1.5 T GE Signa. Localizing images were acquired and used to position a series of axial T_2 weighted FSE images from the prostatic apex to seminal vesicles. These were used to position spectroscopic voxels in regions of abnormality. Spectra were obtained using STEAM at TE = 30 ms (TR/TM = 1 s/32.5 ms), and water reference spectra were acquired with TR = 10 s and at TE = 30, 50, 100 and 200 ms. Citrate concentrations and citrate:choline ratios were calculated. Dynamic contrast-enhanced MRI was also performed as part of an on-going study. Proton density FSPGR images (TR/TE = 120/2.9 ms and 8°) were collected prior to dynamic imaging (0.1 mmol Gd-DTPA, 35 time points, 11 s temporal resolution) using an FSPGR sequence (TR/TE = 10.4/2.9 ms and 25°). Parameter maps of enhancement factor EF, (maximum and at 1'38") and time-to-maximum were calculated for comparison with MRS voxels. RESULTS: Significant differences between tumour and BPH were demonstrated for citrate and citrate:choline ratio. Maximum EF for tumour was higher than BPH, but not significantly different. However, EF at 1'38" demonstrated marginal significance and T_{max} differences were significant. CONCLUSIONS: The results demonstrate the potential of both techniques in discriminating prostate pathologies.

0840
The value of seminal vesicle (SV) biopsy in suspected prostate cancer: results in patients with PSA levels greater than 10 ng ml^{-1}

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INTRODUCTION: Prior identification of seminal vesicle involvement by prostate cancer (CaP) is difficult: Digital rectal examination (DRE), TRUS, CT and prostate specific antigen (PSA) levels have their limitations and MRI is not yet readily available. We have assessed the value of TRUS-guided seminal vesicle (SV) biopsy in tumour staging. PATIENTS AND METHODS: All patients with PSA > 10 ng ml^{-1} and who had sextant biopsies taken to exclude CaP, also had a further biopsy taken through the base of each seminal vesicle, with the trajectory targeted to avoid prostate tissue. RESULTS: Results on 100 men (200 seminal vesicles) are available so far. Of 49 men with biopsy proof of CaP, 22 (45%) also had SV involvement on biopsy. DRE and TRUS were poor predictors of SV involvement (11/22 and 15/22 respectively). Median PSA values (ng ml^{-1}) were higher with SV involvement [26 *vs* 19 (range 10–155 *vs* 10–64)] but not statistically different. Details of biopsy technique and morbidity will also be discussed. CONCLUSIONS: Seminal

vesicle biopsy is helpful in the management of CaP and can be easily incorporated into a sextant biopsy programme. The study is now being extended to include patients with PSA of 4–10 ng ml^{-1}.

0850
Review of outside cross-sectional imaging by oncological radiologists: does it make a difference?
G J Loughrey, B M Carrington, H Anderson, M J Dobson and F Lo
Pat Seed Department, Christie Hospital NHS Trust, Manchester M20 4BX, UK
PURPOSE: To determine whether oncological radiology review of outside cross-sectional imaging affects patient management. MATERIALS AND METHODS: 526 patients attending a regional oncology centre had review of outside cross-sectional imaging over 1 year. The number of examinations per patient; time interval between examination and review request; and scan technical adequacy (coverage, bowel opacification, iv contrast usage) were recorded. More detailed evaluation of 125 patients (case notes available in 107) included comparison of outside and review reports for fundamental or qualitative (completeness) differences in interpretation by a clinical oncologist, with evaluation of the review's impact on management. Examinations which caused major report discrepancies were subjected to independent radiological adjudication. RESULTS: 98% of patients had one or two examinations reviewed. 81% of examinations were reviewed within 3 months of being performed and 88% were technically adequate. There was a fundamental interpretation difference in 35% of examinations and the specialist review was adjudged qualitatively superior in 80%. IMPACT ON MANAGEMENT: Specialist radiological review affected management in 8.5% of patients. 33% of patients either had treatment (26%) or repeat cross-sectional imaging at the oncology centre (7%) before the review was requested. The review report was not mentioned in 29% of case-notes. CONCLUSION: Specialist oncological radiology review of outside imaging gave a more complete authoritative report which fundamentally differed from the outside report in 35% of our series. However, it affected management in only 8.5% of patients. Our results indicate that North Western oncological cross-sectional imaging is technically satisfactory, probably helped by recent Royal College of Radiologists' guidelines, but there may be a need to issue similar guidelines on image interpretation and report presentation.

0900–1030
State of the Art Symposium
Education and Training in Interventional Radiology
Hall 1

0900
Invited Review
Virtual reality and simulation techniques for interventional training
S L Dawson and J A Kaufman
Department of Radiology, Massachusetts General Hospital, Boston, MA 02114, USA
Since the time of the Egyptians, the training of physicians in procedural medicine has relied on the master–apprentice system, wherein a student acquires the techniques of medicine from a learned teacher. This system is highly inefficient and expensive, both in terms of money and time, but it survived because there was no alternative. Today, the availability of high speed computing, graphics programs and force-feedback devices allows the alternative of computer-based training to replace the student's early experiences with patients. Interventional radiology and cardiology are ideally suited for such learning because the images are 2D, black and white and displayed on a video monitor. Massachusetts General Hospital (MGH), through its minimally invasive centre, CIMIT, has begun a long-term collaborative research agreement committed to the development of computer-based training methods which integrate touch with sight. Procedures are integrated into high end silicon graphics work-stations from actual cases performed in the departments. Complications are elicited by errors performed by the student. Custom fabricated interface devices allow the trainee to interact with the anatomy in a realistic fashion, at real-time rates. Successful production of these devices requires a combined effort of physicians, engineers and software designers. Initial testing will occur at the MGH and will include outcomes assessment of the effect which exposure to computer-based learning has on the learning curve of young physicians. This presentation will explain our development programme and possible future applications in training, testing and certification of interventionalists.

0925
Invited Review
Fellowship training in interventional radiology: is an organ system approach appropriate?
P R Mueller
Massachusetts General Hospital, Boston, Massachusetts, USA
Abstract not available.

0950
Invited Review
The animal laboratory as a training resource
R F Dondelinger, M Ghysels, D Brisbois, E Donkers, F Snaps and J Saunders
Department of Medical-Imaging, University Hospital Sart Tilman, B4000-Liege, Belgium
PURPOSE: To demonstrate the possibilities of training in interventional radiology using a porcine model. MATERIALS AND METHODS: Vascular and non-vascular radiological anatomy was studied in 100 female Landrace pigs weighing 20–25 kg. Selective digital subtraction angiography of all vascular territories was obtained. In selected animals, CT and MRI studies of the head and body were added. Frozen anatomical sections and acrylic casts of vascular and non-vascular structures (tracheobronchial system, biliary tree) were also performed. RESULTS: The pig shows many similarities to human anatomy, which makes it a suitable model for use in training: angiographic catheterization techniques, including the use of microcatheters; percutaneous transluminal angioplasty and stent placement in arteries and veins; vena cava filter placement; vascular foreign body retrieval; TIPSS; vascular embolization; biopsy; endoscopic procedures in the tracheobronchial system and upper GI tract; ERCP-derived techniques; percutaneous cholecystostomy; gastrostomy; nephrostomy; cystostomy; and endovascular US, etc. Catheterization of intracerebral arteries, abdominal aortic stent grafting and percutaneous biliary drainage can not realistically be attempted because of the specific anatomy of the pig. During the training sessions, three students perform the procedures, working two by two under the direction of an instructor. Lesions, such as vascular stenoses, choledocal and ureteral obstruction can be created by surgical preparation of the animal. The training sessions offer the opportunity for the students to use catheters, guide wires, stents, embolization material and other devices from various manufacturers. CONCLUSION: Training in an animal model should become an integrated part of education in interventional radiology.

1015
Discussion

0900–1040
State of the Art Symposium
Gastrointestinal tract
Hall 9

0900
Invited Review
Abdominal obstruction—a radiographer's perspective
L McNamee and R Waterfield
Diagnostic Imaging Department, Northern General Hospital Sheffield S5 7AU, UK
In the Accident and Emergency Department (A&E) of any acute general hospital the vast majority of patients are managed by Senior House Officers who are relatively inexperienced. The greatest difficulties faced by these doctors include deciding whether or not to X-ray the patient and being confident in the interpretation of the radiographs. Although there are many safety nets built into A&E practise in the well-run department, designed so as to limit the problems caused by inaccurate interpretation of radiographs, mistakes will continue to occur, given the large numbers of injured patients who attend on every day of the week. It is with these issues and others in mind, that the radiographic profession is moving towards the official reporting of A&E radiographs by radiographers (those with MSc and post-graduate diplomas/certificates in radiographic reporting). At present, most departments already incorporate a Red Dot system for A&E films. It is hoped that the simple

and logical approach of this lecture will help reinforce basic pattern-recognition skills of radiographers, regarding radiographs, demonstrating abdominal obstruction and give an insight into US appearances of abdominal obstruction. As strong advocates of role-extension for radiographers in the remit of radiographer reporting, we believe that the introduction of continuing professional development will encourage more radiographers to attend lectures and seminars aimed at reinforcing pattern-recognition techniques and promote their skill in a reporting role within, particularly, the A&E environment.

0930
Invited Review
Plain film diagnosis of intestinal obstruction
S Field
Department of Diagnostic Radiology, Kent and Canterbury Hospital, Canterbury CT1 3NG, UK
Intestinal obstruction continues to be one of the commonest reasons for acute admissions to surgical beds in a hospital. Other imaging modalities may play a valuable role but the initial investigation of these patients is still plain film radiology although their interpretation is full of pitfalls. The value and limitations of plain film radiography in diagnosis of intestinal obstruction will be discussed.

0950
Invited Review
Imaging in intestinal obstruction: after the plain film
P J Shorvon
Department of Radiology, Central Middlesex Hospital NHS Trust, London NW10 7NS, UK
Conventional management of patients after a clinical or radiological diagnosis of intestinal obstruction involves the use of oral or rectal contrast administration. Upper GI intubation studies are also used, particularly in patients with intermittent obstruction. Recently, there has been a shift away from these methods. Some proponents of ultrasonography utilize this method for demonstrating both the site and cause of obstruction. This has the advantage of avoiding irradiation and can be definitive. However, often ultrasonography will be inconclusive and further imaging is required. Spiral CT has made a large impact on imaging of intestinal obstruction. The examination is performed quickly and with minimal discomfort to the patient. No oral or rectal contrast is necessary and the method is proving very sensitive for the detection of obstruction and reasonably specific for the cause. It is also very sensitive for detecting free intraperitoneal air and identifying patients with other complications, such as bowel necrosis. The advantages and disadvantages of these various imaging modalities will be discussed and their use in various clinical scenarios outlined.

1010
Metastasis to gastrointestinal tract from breast carcinoma: lobular *vs* ductal carcinoma
J P Lay, S A Sukumar, C R M Boggis and A Howell
Department of Radiology, Withington Hospital, Manchester M20 2LR, UK
PURPOSE: A retrospective imaging study of the abdominal CT scans of patients with breast carcinoma to assess the different patterns of intra-abdominal metastasis of ductal and lobular carcinomas. MATERIALS/METHODS: The abdominal CT scans of 46 patients with breast carcinoma and a variety of abdominal symptoms were reviewed separately by two radiologists, blind to the histological diagnosis, to assess the extent of metastatic disease. Fisher's exact test was used to compare the number of metastatic events to a particular site. RESULTS: The histological diagnoses of the 46 patients was 32 invasive ductal carcinoma, 11 lobular carcinoma and three unspecified. Of the 11 patients with lobular carcinomas five had metastases in bowel or mesentry. Both patients with gastrointestinal tract metastasis from ductal carcinomas had liver metastasis as well, whereas none of the five patients with gastrointestinal tract metastasis from lobular carcinomas had liver metastasis. CONCLUSIONS: There was a significantly higher incidence of gastrointestinal tract metastasis from invasive lobular carcinoma, compared with ductal carcinoma ($p=0.008$). Bowel or mesenteric metastasis can occur in the absence of liver involvement in lobular carcinoma; whereas in ductal carcinoma gastrointestinal metastasis appears to occur when liver metastasis is present. This may have implications in imaging strategy in patients with lobular carcinoma.

1020
CT in non-traumatic acute abdominal pain
I D Lyburn, N F Slack and A J Longstaff
Department of General Radiology, Frenchay Hospital, Bristol BS16 1LE, UK
INTRODUCTION: Patients presenting with acute abdominal pain often have an unclear clinical picture. Increasing the likelihood of reaching the correct diagnosis aids determination of appropriate management, medical or surgical. The role of abdominal CT is evaluated. MATERIALS/METHODS: 100 CT reports performed on patients with abdominal pain of less than 5 days duration were reviewed. Findings were correlated with the results of other investigations, surgery and pathological examination, when available, and/or clinical follow-up. Using a conventional, third generation, CT scanner, images had been obtained from the diaphragm to the symphysis pubis: 10 mm thick at 10 or 15 mm intervals. In many cases oral and/or iv contrast was administered. Further examination was undertaken in certain cases utilizing iv contrast (if not given during the initial scan) and/or changing patient position and/or acquiring thinner slices (5 mm) in selected regions. RESULTS: There was a spectrum of reports, ranging from no abnormality to specific findings, including appendicitis, diverticulitis, pancreatitis, cholecystitis, intestinal obstruction, colitis and colonic carcinoma. In 86% of cases CT findings correlated well with other investigations and clinical details. Drainage under radiological guidance was performed in three patients who required no further intervention. CONCLUSION: CT is very useful in assessing patients with non-traumatic abdominal pain. The presence of disease can be defined and localized to a specific organ or organ system and, in some cases, radiological intervention is aided with the avoidance of surgery.

1030
Screening for intraabdominal drug concealment: does it work?
F Lo
X-ray Department, Wythenshawe Hospital, Southmoor Road, Manchester M23 9LD, UK
PURPOSE: To ascertain how effective the simple abdominal radiograph is in detecting drug packets in body-packers. METHODS: From January 1994 to December 1996, we performed abdominal radiographs on 198 suspected body-packers for HM Customs at Manchester Airport. All those with suspicious radiographs were detained for intimate search, including stool examination for possible intraabdominal drug concealment. RESULTS: 24 radiographs were reported as definite or highly suspicious (12.1%). In 20 cases illicit material was subsequently recovered (from 10 g of cannabis to over 200 packets of cocaine), that is a specificity of 83%. The professional smuggler carries on average 60–80 packets intraabdominally. There were four false positive cases. Three involved suspicious "masses" in the stomach (one of which was a parasite) and one was a rectal mass, shown to be dense faeces. We reported a further 21 cases as suspicious, or of low suspicion. Only one case was positive (<5%). Most of these suspicious cases had dense faeces in the rectum, which can mimic drug packets. One or two stool examinations is often sufficient to confirm the absence of a drug. We could not be certain of the true number of false negatives, as those with normal radiographs were not detained. However, this is likely to be low. CONCLUSION: We believe the abdominal radiograph is an effective tool for HM Customs. It can act as a deterrent and prevents unnecessary, long custom-detention for some.

0900–1000
Scientific Session
*info*RAD™ 1—Information Systems
Hall 10a

0900
Invited Review
Buying a radiology information system
D J Harvey
Radiology Department, Singleton Hospital, Swansea NHS Trust, Swansea SA2 8QA, UK
Most radiology departments in this country already operate some form of computerized radiology information system. Many of these, however, will need replacement in the next few years, due to a combination of departmental growth, technological advances, or even the "year 2000" problem. A large number of systems are

available commercially and it is important to make a good choice in order to ensure maximum possible usefulness in the future. Whilst current systems operate largely independently, perhaps with just a connection to the hospital's patient administration system, the emphasis in the future will be on integration; direct communications with wards and GPs will be required for both requests and results. Looking further ahead, direct communications between the radiology information system and imaging equipment will become increasingly important, especially with the advent of PACS. This type of functionality will probably be required within the life of any system bought today, despite the fact that such communications are rarely used at present and in many cases are yet to be defined. Moreover, there may be integration and data extraction requirements which have not even been considered yet. It is therefore important that any radiology information system be based on a flexible and well-designed database, such that later enhancements may be provided with minimal disruption. Other important features to consider include the user interface, which must be designed to provide maximum functionality with minimal training, and system security, a wide field which includes confidentiality, data integrity, and resilience.

0930
Reporting with a voice recognition system—effect upon radiologists' time compared with a conventional system
R J Etherington
Department of Radiology, Countess of Chester Hospital, Chester CH2 1UL, UK
PURPOSE: To assess the potential impact of a voice recognition system on the time taken for a radiologist to produce a report. METHOD: 100 films were reported "conventionally", using a Dictaphone Thought Tank and using an IBM Voice Type voice recognition package. RESULTS: The Voice Type system was over 90% accurate, but increased radiologist input in the production of a report resulted in a threefold increase in radiological time per report. CONCLUSION: As used in this study, voice recognition would result in a three-fold reduction in radiological throughput. Technological improvements have the potential to decrease this disadvantage.

0940
Discussion

0900–0945
British Institute of Radiology
Presidential Address
Hall 10b

0900
Evidence based imaging
M Smith
Research School of Medicine, Leeds LS2 9LN, UK
No abstract.

0900–1010
Scientific Session
Musculoskeletal Trauma 1
Hall 11a

0900
Invited Review
Paediatric elbow trauma
P G White
Morriston Hospital NHS Trust, Department of Radiology, Morriston, Swansea SA6 6NL, UK
Plain radiographic interpretation of the paediatric elbow is difficult because the cartilage parts of the epiphyses are not visible, also because a wide range of injuries can occur and there are many normal variants. This presentation helps in the detection of subtle injuries by reviewing important anatomical features, such as the anterior humeral and radiocapitellar lines, and the order of appearance of the ossification centres. The displaced fat pad sign is valuable, with some differences from the same finding in adults. The mechanisms of trauma giving rise to different patterns of injuries are considered, for example, in extension of the elbow the olecranon is "locked" in its fossa, so a valgus force produces a transverse fracture, often associated with a radial neck fracture. It is important to recognize injuries requiring surgical intervention, such as intraarticular displacement of an avulsed medial epicondyle, a displaced lateral condylar fracture, or dislocation of the radial head. Comparison views of the uninjured elbow can be helpful in identifying normal variants and subtle injuries, especially for less experienced staff, but it is controversial whether these should be obtained routinely. US and MRI can be used to visualize the cartilage structures of the elbow prior to the appearance of the ossification centres. Panner's disease and osteochondritis dissecans are trauma-related conditions which may require further imaging, as can post-traumatic complications, including malunion and growth plate injuries.

0930
Diagnostic and therapeutic impact of MRI and arthrography in the investigation of shoulder pain
[1]T K Blanchard, [1]P W Bearcroft, [2]C R Constant, [2]D Griffin and [1]A K Dixon
Departments of [1]Radiology and [2]Orthopaedics, Addenbrooke's Hospital and the University of Cambridge, Cambridge CB2 2QQ, UK
PURPOSE: Little is known about the relative diagnostic and therapeutic impact of MRI and arthrography for full thickness rotator cuff tears (FTRCT). We have performed a prospective trial in which these investigations were compared. METHODS: 104 consecutive patients presenting with shoulder pain underwent pre-operative MRI and arthrography. The surgeon's diagnosis, diagnostic confidence and planned treatment were measured at outset and after the results of each investigation. Before the presentation of the investigation results, the patients were randomized into two groups: in one, MRI results were presented first, in the other, arthrography. Hence, the diagnostic and therapeutic impact of the two investigations could be compared. Data about the accuracy of each investigations were calculated for those patients who underwent surgery. RESULTS: The arthrographic findings led to slightly more changes in diagnostic confidence (20/54, 37%) than MRI (14/46, 30%) but this difference was not statistically significant ($p > 0.7$). MRI led to slightly more changes in management (17/47, 36%) than arthrography (14/55, 25%), but again the difference was not significant ($p > 0.3$). The second investigation always had less diagnostic and therapeutic impact than the first. The accuracy, sensitivity and specificity of MRI ($n = 38$) for FTRCT was 79%, 81%, 78%, respectively; and for arthrography ($n = 38$) was 82%, 50%, 96%, respectively. CONCLUSION: Clinical diagnosis and management plan can usually be adequately refined by a single radiological investigation. MRI and arthrography have similar diagnostic and therapeutic impact and have comparable overall accuracy. MRI may be preferred because of its better demonstration of soft tissue anatomy.

0940
Full thickness rotator cuff tears: evaluation by single sequence (STIR) MRI
S J Wadsworth, E G McNally, T Bonomo and A Carr
Nuffield Orthopaedic Centre, Oxford OX3 7LD, UK
PURPOSE: To evaluate single sequence (STIR) MRI in detecting full thickness tears of the rotator cuff. MATERIALS AND METHODS: 33 patients with impingement were referred. Coronal oblique STIR sequence images only were obtained. Findings were categorized into full thickness tears or non-full thickness tears. All patients had subsequent arthroscopy. RESULTS: 18 patients had full thickness tears on MRI confirmed at arthroscopy. 14 patients had no full thickness tear, also confirmed at arthroscopy. There were no false negatives, but one false positive. The positive predictive value is 95%, negative predictive value is 100%. Sensitivity 100%, specificity 93%, accuracy 97%. CONCLUSION: Providing that the detection of partial thickness tears is clinically not relevant and good fat suppression is used, single sequence (STIR) MRI is as accurate as multiple sequences in detection of full thickness rotator cuff tears. The accurate detection of partial thickness tears probably requires MRI arthrography.

0950
Visualization of the coraco–acromial ligament on double oblique sagittal MRI of the shoulder
[1]A L Hine, [2]S Tennant and [2]R J Emery
[1]Department of Radiology, Central Middlesex Hospital, London NW10 7NS and [2]Department of Orthopaedics, St Mary's Hospital, London W2 1NY, UK
PURPOSE: To evaluate the coraco–acromial ligament on MRI of the shoulder using a double oblique sagittal scanning plane of the shoulder. METHOD: The standard oblique sagittal imaging plane

was tilted 20° in the vertical plane to obtain a scanning plane approximately along the coraco–acromial ligament. A T_2 weighted sequence was employed. The visualization and appearance of the coraco–acromial ligament in 30 shoulders has been assessed. RESULTS: The coraco–acromial ligament was visualized on all examinations and in 20 shoulders the whole length of the ligament was seen on two or more slices. The ligament varied in thickness and degree of convexity. A triangular-shaped area of signal void was seen at the acromial insertion of the ligament in 15 shoulders. The bony margin of the lateral acromion at the insertion of the ligament was pointed in 22 examinations and rounded in eight. CONCLUSION: The double oblique sagittal imaging plane is very useful for delineating the coraco-acromial ligament. It permits detailed assessment of the ligament and its insertion into the lateral acromion.

1000
Diagnosis of rotator cuff tears by dynamic indirect MR arthrography
[1]K-H Allmann, [1]O Walter, [1]A Gabelmann, [1]J Laubenberger, [2]A Reichelt and [1]M Langer
Departments of [1]Radiology and [2]Orthopaedic Surgery, Freiburg University Hospital, Hugstetterstrasse 55, D-79106 Freiburg, Germany
PURPOSE: The purpose of this study was to evaluate the diagnostic value of dynamic indirect MRI arthrography in rotator cuff tears. MATERIALS AND METHODS: The authors examined the effect of an iv dose of gadolinium (gadopentetate dimeglumine) (0.1 mmol kg^{-1}) on the signal intensity of the shoulder joint cavity. Dynamic indirect MR arthrographic outcome in 20 patients with suspected rotator cuff tears were compared with the surgical findings. RESULTS: Fat-saturated images obtained 4 min after the administration of 0.1 mmol kg^{-1} gadolinium demonstrated an increase of signal intensity within the joint cavity of 220%, without exercising the shoulder. With this method, size and position of the rotator cuff tears were better delineated than with unenhanced MRI and showed a good correlation with surgical results. CONCLUSION: Dynamic, indirect MR arthrography of a non-exercised shoulder can be successfully used to diagnose rotator cuff tears. In addition, application of sagittal and oblique-coronal sections allows the demonstration of the size and position of rotator cuff tears.

0900–1030
State of the Art Symposium
Nuclear Medicine and Hypoxia
Hall 11b

0900
Invited Review
Radiopharmaceuticals for imaging hypoxia
C M Archer
Healthcare Development Projects, Nycomed Amersham plc, Amersham HP7 9LL, UK
PURPOSE: To review the current progress and clinical aims of research to develop radiolabelled diagnostic agents for the clinical detection of tissue hypoxia. SUMMARY: Compounds containing 2-nitroimidazole groups have long been studied as potential radiation sensitizers for the treatment of solid tumours. These compounds are retained in hypoxic tissues because of the selective bioreduction of the 2-nitroimidazole group in poorly perfused, but functioning (hypoxic), tissues. Within the last decade several compounds containing either a 2-nitroimidazole or another bioreductive group have been developed as possible diagnostic markers of tissue hypoxia for use in a range of potential clinical applications. The molecules studied to date range in size from the relatively simple ^{18}F-fluoromisonidazole (FMISO) through to the substituted sugar molecule, ^{123}I-iodoazomycin arabinoside. Compounds labelled with radiometals have also been developed, based on the chemistry of either the γ-emitting radionuclide $^{99}Tc^{m}$ or the positron emitter ^{62}Cu. Work to date in this field will be reviewed in this presentation.

0920
Invited Review
Hypoxia in cardiology
V Lewington
Southampton General Hospital, Tremona Road, Southampton SO9 4XY, UK
Abstract not available.

0940
Invited Review
Nuclear medicine and hypoxia in oncology
G J R Cook
Department of Nuclear Medicine, Guy's Hospital, London SE1 9RT, UK
Tumour hypoxia confers resistance to radiation therapy and some forms of chemotherapy, and may influence prognosis. The recognition of a hypoxic tumour fraction can have implications for therapy, the use of radiosensitization drugs or hyperbaric oxygen having been investigated as methods of improving outcome. Unfortunately, it is not possible to predict tumour hypoxia, there being both inter- and intra-tumoral heterogeneity in oxygen status. Tumour hypoxia may be measured directly by oxygen electrodes, but this technique is technically complex and not suitable as a routine diagnostic tool. MR spectroscopy may non-invasively measure tumour oxygen status, but is not generally available. There has therefore been much interest in the development of nuclear medicine imaging of radiolabelled compounds that are selectively retained in regions of hypoxia. The PET tracer, ^{18}F misonidazole has been evaluated in a number of tumours, but the more ready availability of gamma camera imaging has led to the development of a number of single photon radiopharmaceuticals. Nitroimidazole-containing compounds have received most attention. The nitro group undergoes one electron reduction to produce a radical anion which, in hypoxic cells, is further reduced to species which react with cell components and are retained. $^{99}Tc^{m}$ labelled ligands containing 2-nitroimadazole show hypoxia selectivity, but a complex of the core ligand without the nitroimidazole group has shown even greater selectivity and is currently being evaluated in patients.

1000
Invited Review
Identification of hypoxic regions in traumatic brain injury
[1]S Vinjamuri, [2]K O'Driscoll, [2]M van den Broek and [1]M Critchley
[1]Nuclear Medicine Department, Royal Liverpool University Hospital, Liverpool L7 8XP and [2]Brain Injury Rehabilitation Centre, Rathbone Hospital, Liverpool, UK
PURPOSE: The assessment of patients with traumatic brain injury (TBI) in the post-acute phase includes MRI, which identifies structural changes, single photon emission tomography (SPET) using a perfusion radionuclide tracer and neuro-psychological testing (NPT). When all three investigations are in agreement, therapeutic planning can be considered to have a strong basis. However, in case of disagreement between the modalities, the significance of the abnormal SPET, MRI and NPT needs to be considered individually. Technical limitations (such as resolution) of SPET and MRI often result in normal findings and yet NPT may be abnormal. The aim of this study was to attempt to identify and characterize the extent of hypoxic injury to the brain in a group of patients with moderate to severe TBI. The hypothesis is that there is a variable element of hypoxic injury in areas with reduced perfusion seen in moderate or severe TBI and that this can be characterized. We also wanted to test whether it would be possible to identify hypoxic areas when the rCBF study was considered normal. METHOD: This hypothesis was tested using ^{123}I-IAZA (iodoazomycin arabinoside) as the hypoxia tracer and $^{99}Tc^{m}$ HMPAO to assess perfusion. Patients were grouped into (i) Normal SPET and MRI with abnormal NPT, (ii) Abnormal SPET and MRI (controls) and (iii) normal volunteers. RESULTS: Preliminary results following the iv injection of 185 MBq of ^{123}I-IAZA and tomographic imaging 5–6 h later showed no retention of radiotracer in the brain of a normal person; retention of hypoxic tracer in patients with normal SPET and abnormal NPT and retention of hypoxic tracer in some patients with abnormal SPET (areas with reduced perfusion but with possible scope for improvement as they are still viable). CONCLUSION: There is a possible complimentary role for hypoxia imaging, together with perfusion SPET, in the evaluation of patients with TBI. A normal perfusion SPET may not exclude hypoxic injury to the brain.

1020
Discussion

0910–1000
Scientific Session
Radiotherapy Planning and Conformal Therapy
Olympian Suite

0910
Acceptance testing of a Helax treatment planning system: irregular field evaluation

[1]R J Lander and [2]A B L Tyler
[1]*Department of Medical Physics and Clinical Engineering, Singleton Hospital, Swansea NHS Trust and* [2]*Department of Medical Physics, Velindre Hospital, Whitchurch, Cardiff, UK*

Acceptance testing of a Helax treatment planning system, (software version Radix 4.0) has included the study of irregular fields created using shielding blocks (constructed from MCP96), positioned both on and off the central axis. Those used included a square central axis block (5×5 cm at 100 cm SSD), a spinal block (2×15 cm at 100 cm SSD) and a mantle field arrangement (15×15 cm field size), consisting of right and left lung blocks and a larynx block. Profile data for these irregular fields were obtained using a $50 \times 50 \times 50$ cm water phantom and Scanditronix RFA 300 Plus dosimetry system. Data were taken from a Varian Clinac 2100 linear accelerator, for both 6 MV and 10 MV photon beams for fields of 15×15 cm and 20×20 cm at depths of 5, 10 and 20 cm. A comparison was made between the measured data and the Helax system calculated data for the same blocking arrangements. This included analysis of the profile shape and position of the 50% width. The results obtained showed a maximum positional difference, at the 50% width, of ≤ 1 mm in the majority of cases. With regard to profile shape, differences were observed at the corners where the Helax profile appeared squarer than the measured profile. None of the differences noted above are of clinical significance. As a result of this study a discrepancy in transmission through the block was observed between the measured and Helax calculated data. This occurred for the 10 MV photon beam only and was in the region of 4%. This finding is currently being investigated by Helax.

0920
Beam model assessment on Plato RTS 2.0 (3D)

G S Shentall and M C Kirby
North Western Medical Physics, Lancashire and Lakeland Radiotherapy Unit, Royal Preston Hospital, Preston PR2 9HT, UK

PURPOSE: Plato RTS 2.0 (3D) was released in the second half of 1997 by Nucletron. The system incorporates a convolution-based approach, that generates depth dose and profile information from a minimal set of input data. Once this data has been entered, beams can be generated for a large range of field sizes and depths, including wedged and blocked fields. This presentation aims to verify the validity of the modelling used in this planning system. MATERIALS AND METHODS: A full set of measured beam data has been collected and systematically compared with that generated by Plato under a variety of conditions. Comparisons have been made with generated profiles, point doses and isodoses. RESULTS: Acceptable results were generated under most circumstances. The physical wedge shape worked well for small wedged fields, but not for large. An alternative wedge shape was generated that improved the fit for large fields, but proved detrimental to smaller fields. CONCLUSIONS: The modelling used is not able to generate beam data over the full set of conditions used in radiotherapy planning, but does adequately cover field sizes and conditions most commonly used.

0930
An investigative study of customized compensation using dynamic intensity modulated multileaf collimator fields

J H L Mott, G J Budgell, A R Hounsell, J R Sykes, J M Wilkinson and P C Williams
North Western Medical Physics, Christie Hospital NHS Trust Manchester M20 4BX, UK

Multileaf collimator (MLC) leaves can be moved dynamically to produce intensity-modulated treatment fields. Such beams can be used for customized compensation of many treatment sites. This presentation reports on an investigative study into customized compensation for pelvic disease, using a four-field treatment technique. In this, a target is delineated on a series of CT slices and related to external body marks using automatic body outlining and graphical overlays. The cross-sectional information is used to create irregularly-shaped projected views, from which MLC leaf positions are automatically calculated. These leaf positions act as the boundaries of the treatment field inside which intensity modulation occurs. The aim is to produce a uniform dose throughout the isocentric plane from each beam direction by compensating for changes in the body surface. The required input intensities are calculated from the depths below the patient surface of a series of points on the isocentric plane. Changes to the intensity and energy of the beam off-axis and a scatter contribution are included in the calculation. The desired intensities are then passed through software which calculates the leaf positions to deliver the required dose distribution. A full dose calculation based on the leaf positions is subsequently performed and compared with the required uniform dose distribution. Differences, if outside pre-determined limits, are used as a basis for modifying the input intensity distribution and hence leaf settings. The process has been successfully tested using a shaped phantom.

0940
A multidisciplinary approach to implement the transition from 2D to 3D conformal therapy

A J Kendrew, A W Beavis, W E Brown, R A Dealey and V J Whitton
Department of Clinical Oncology, Princess Royal Hospital, Hull, HU8 9HE, UK

PURPOSE: We will present an overview of the project in progress within our clinical department to make the transition from conventional 2D radiotherapy techniques to those required for 3D conformal radiotherapy. This necessitates good localization of patients, via immobilization and fixation devices, and subsequent verification. METHODS: We audited our current practice, identifying areas where improvements were possible. Four main areas were identified: localization, fixation, verification and data transfer. Improvements had to be made within the constraints of available resources. Multidisciplinary task groups were created to facilitate changes. Each group had an assigned radiographer, physicist and technician to advise, oversee and feedback to a central steering group. This methodology enabled the existing procedures to be enhanced from "the ground up" with a holistic view. It was decided that initially a subset of treatment sites and patients would be treated using conformal techniques, these were pelvis and head/neck. RESULTS: Various solutions were proposed to each problem, the team-based approach enabled "user friendly" improvements to be implemented. A workable "best practice" was redefined for each group. Examples of improved practice will be presented, including foot-rest and skin-marks for pelvic treatments and redesign of treatment shells for head and neck treatments. CONCLUSION: The approach taken has enabled a firm basis to be established and gradually implemented. It has increased faith in the developing techniques within the radiotherapy department and the confidence to utilize them.

0950
Virtual dosimetry: quality control of dynamic intensity modulated radiation therapy

A W Beavis, J Kennerley and V J Whitton
Department of Medical Physics, Princess Royal Hospital, Hull HU8 9HE, UK

PURPOSE: Modern radiotherapy practice is universally tending towards conformal therapy, in which the high dose volume is designed to conform closely to the tumour volume and conformally avoid uninvolved organs. Dynamic intensity modulation is a method by which this may be attained. Delivery parameters, such as collimator (or MLC) positions, gantry angle, dose rate and even couch position may be altered to obtain modulation of the delivered dose. To maintain confidence in clinical delivery, good quality control (QC) must be performed; however, conventional methods are rendered impotent. METHODS: We have developed a data-logging facility on our Clinac 600C, enabling monitoring of delivery parameters (such as dose rate and collimator position) during each beam delivery. The methodology was developed for QC of our enhanced dynamic wedge (EDW). To analyse this considerable volume of data (7500 data points/"beam on minute") software tools have been developed in-house. One such tool utilizes a "neural network". The analysis software is trained to recognize patterns in data, such as a "signature" associated with a particular wedge angle. It is able to recognize that, for example, a 25° Y1 wedge was delivered. RESULTS: The data taken from the Clinac has been calibrated, providing a redundant quantitative QC test on the delivery integrity of the EDW. The neural network provides a qualitative QC test whose results may be included in the patient's records. CONCLUSION: The QC system presented here is considered a "virtual dosimetry" system, complementing and, potentially, replacing conventional dosimetry methodologies.

MONDAY

1015–1230 Symposium **Medical History** Hall 10a

1015
Invited Review
The electron and the atom—contributions to medicine
I Isherwood
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The discovery of the electron by J J Thomson in 1897 and the elucidation of atomic structure by Lord Rutherford and others in subsequent years were events which had a profound influence on 20th century science and, indeed, on the way we presently conduct our lives. Medicine has been one of the principal beneficiaries and much of the knowledge gained over the last 100 years has been a direct result of our understanding of the first elementary particle—a constituent of all matter, and the atom. The effect of this understanding on the physical, chemical and biological sciences and the manner in which it has transformed medicine has been such that it is impossible in a single review to do more than acknowledge numerous contributions. The harnessing of electricity, the development of electronic equipment and the universal acceptance of computing have, for example, all led to huge advances in measuring equipment and microscopy; not to mention television the domestic electron accelerator. Diagnostic imaging and much of radiotherapy is now based on the understanding and the power to manipulate the components of atomic structure. Electron transfer as the basis of modern medicinal chemistry has also led to many new opportunities in preventive, diagnostic and treatment options. There is every reason to believe that the radiological sciences in particular will continue to benefit from the fundamental *fin de siècle* observations which so influenced the subsequent scientific and medical advances of the 20th century.

1100
Invited Review
The Society of Apothecaries and women's quest for medical qualification 1860–1895
D A Cook
The Worshipful Society of Apothecaries of London, London EC4V 6EJ, UK
In 1617 the Worshipful Society of Apothecaries of London, a City Livery Company, was granted its charter of incorporation by James I. Originally compounders and dispensers of drugs, apothecaries won the right to prescribe them, formerly the exclusive province of physicians, in 1704, following a ruling in the House of Lords. Apothecaries thus became medical practitioners, recognized in law. The Apothecaries' Act of 1815 empowered the Society to institute a Court of Examiners and it became the first medical licensing body to set up a formal curriculum of combined study and practical hospital experience. Any person wishing to practise as an apothecary in England and Wales had to qualify as a Licentiate of the Society of Apothecaries (LSA), but it had not been envisaged that women would apply for this Licence. In 1865, when no other licensing body accepted women candidates, and having taken Counsel's opinion in the hope of excluding women from its examinations, the Society was forced to grant its diploma to Elizabeth Garrett (afterwards Garrett Anderson), the first woman doctor to qualify in Britain. The Court of Examiners changed its regulations in 1867, effectively barring women until 1888, when the Society's opposition crumbled. This paper aims to provide a short account of the issues and attitudes prevalent between 1860 and 1888 and of women's battles against bigotry and obstruction. It will also present brief biographies of a few of the 30 women who qualified LSA between 1888 and 1895, the period immediately prior to the birth of radiology.

1120
Invited Review
Women-run hospitals in Britain, 1872–1929
P D Mohr
Hope Hospital, Salford M6 8HD, UK
The importance of the medical women's hospital movement for women's entry to the medical profession has only been recognized in recent years. The movement started with Dr Garrett Anderson's St Mary's Dispensary in 1866 and continued to the opening of the Marie Curie Hospital in 1929. There were about a dozen hospitals established and run by women doctors; they were not organized in any formal way—the institutions varied widely in their character. Some, like the New Sussex Hospital (1912), were intended for general surgery, others, like the Manchester Babies' Hospital (1914), were specialist institutions. This paper argues that "women-run hospitals" were crucial to the professional development of women doctors. Gaining entry to the Medical Register in 1877 was not in itself sufficient to ensure a place for women in the profession: their problem simply changed from one of "becoming a doctor" to one of "being a doctor". The women-run hospitals allowed female medical students to gain undergraduate clinical teaching, gave the newly qualified woman doctor a first step on to the career ladder, opened the door to post-graduate education and specialization, provided valuable consultant and research posts for senior women doctors, and later helped to extend the work of medical women into paediatrics and general medicine. Before the NHS, the women-run hospitals were beacons for medical women; the success of a few illustrated the possibilities for the others.

1140
Invited Review
Women in radiology
U Busch
German Röntgen-Museum, 42897 Remscheid, Germany
Professor Röntgen was the first human being who X-rayed and saw the bones of his own hand. He asked his wife, Anna Bertha, on 22nd December 1895, whether she would allow him to screen her hand. On the developed photo plate the bones of her hand and two rings can be distinctly seen. This photograph has become a historic document. Unfortunately, we do not know how Mrs Röntgen reacted to the photo plate of her bones. The reaction of many women—maybe even of Mrs Röntgen—was distaste. The sight of ones own skeleton raised the presentiment of death rather than fascination. A short time after the news of X-rays had spread, a moral campaign started against them. It was not only highly moral citizens who were shocked by the thought of being constantly exposed to the penetrating rays. The interest of women in the new rays was also socially proscribed. The "natural determination" of women was fixed to the tasks of housewife and mother. Higher educational training, or even preliminary studies at university were not available for women; the very idea evoked heavy male anger. Even now it seems that women are not leading actors in the field of radiology for, although the staff of a radiological clinic are mainly female, the key positions are chiefly occupied by men. A retrospective glance at the history of women in radiology is by no means meant as an accusation, but more as an encouragement to find ways to provide equality for women and men.

1200
Invited Review
Pioneering X-rays at a Scottish Women's Hospital on the Western Front
E C Crofton
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On the outbreak of war in 1914, the Scottish Federation of the National Union of Women's Suffrage Societies formed a number of hospital units, to be staffed entirely by women, prepared to serve in allied theatres of war as required. This talk centres on the French unit which operated continuously from December 1914 to March 1919. The original 100 beds increased to 600 by the end of the war when it was recognized as one of the most efficient hospitals serving the French army. The talk will include an account of the development of an effective system for the use of X-rays, together with clinical assessment and bacteriological examination, to determine appropriate prioritization of battle casuaties for operation. With an almost universal incidence of infection with the organisms of gas gangrene these methods, combined with judicious use of anti-gas gangrene sera, enabled them to achieve remarkable results. The drama of the battle of the Somme, the evacuation of their advanced hospital during the German advances of 1918 and the subsequent intense pressure of work in all sections of the hospital will be described. The advantages and disadvantages of the types of apparatus used will be discussed and some account given of the personalities involved in the X-ray rooms.

1220
Discussion

1020–1150
Scientific Session
Advanced Breast Imaging
Olympian Suite

1020

Diffraction enhanced imaging: a new technique for obtaining superior breast images

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Monochromatic synchrotron radiation X-rays at the National Synchrotron Light Source and the Advanced Photon Source have been used to study the optimization of mammography. Images have been recorded on film and image plates and compared with images taken with a state-of-the-art clinical system. The synchrotron images show improved contrast due to reduced scatter and the high degree of monochromatization of the beam. We have extended this work and developed a new imaging technique called diffraction enhanced imaging (DEI) that dramatically increases the image contrast. Images of the index of refraction and the apparent absorption are independently obtained by using an analyser crystal after the sample. The index of refraction is sensitive to density variations and boundaries. The apparent absorption is due to the standard absorption seen in radiography, as well as extinction of the X-rays due to small angle scattering. Since the analyser transmits only non-deviated rays, small angle scattering differences between tissues show up as differences in apparent absorption, resulting in contrast enhancement. The index of refraction images and the extinction contribution to the apparent absorption are independent of photon energy in this method. The use of higher energy photons should result in the same information in the images, but at a reduced absorbed dose. Studies of these effects and the results of imaging excised breast tissue and phantoms will be presented. The use of the DEI imaging technique results in dramatic improvements in the images at lower absorbed dose and may be applicable to mammography.

1030

Region of interest analysis of dynamic breast MRI

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PURPOSE: A standardized method of region of interest (ROI) analysis of dynamic breast MRI data has yet to be established. Several authors have emphasized that mean pixel values of large ROIs conceal tumour heterogeneity and that it is preferable to identify areas with the highest enhancement values, rather than to determine a mean value for the entire lesion. The aim of this work, therefore, was to determine whether pixel thresholding is useful in the ROI analysis and interpretation of primary abnormalities seen at breast MRI. METHODS: MRI of the breast was accomplished using a 1.5 T GE scanner. Dynamic contrast-enhanced imaging was performed, with 25 sequential images acquired at a temporal resolution of 12 s, during and immediately after the iv bolus injection of 0.1 mmol kg^{-1} body weight of Gd-DTPA. After acquisition, manual ROIs for every tumour were drawn by an experienced radiologist and for each ROI the dynamic data was processed, pixel by pixel, to calculate the relative increase in signal at 1 min (ER_1) after contrast injection, since this is a typical enhancement characteristic used in the assessment of breast MRI. Thresholding was performed for each ROI to identify those pixels within a certain percentage of the maximum value and, at each threshold level, the enhancement values of the selected pixels were averaged to calculate a mean ER_1 value. Receiver operating characteristic (ROC) analysis was then used to assess the diagnostic efficacy of ER_1. RESULTS: 71 invasive carcinomas and 37 benign lesions were analysed. Highly significant ER_1 differences were noted between benign lesions and carcinomas ($p<0.0005$) at all threshold levels. Mean enhancement differences increased with narrower thresholding, but the standard deviation of measurements also rose in a linear fashion. As a result of this, the diagnostic performance of ER_1 was unaffected by the thresholding process. ROC analysis revealed $A_z=0.73\pm0.05$, throughout the range of the threshold levels used. CONCLUSION: Contrary to current opinion, selective sampling of the most enhancing areas of breast abnormalities does not offer any diagnostic advantage over the use of lesion-encompassing ROIs.

1040

Use of MRI to classify *de novo* architectural distortion of the breast

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Co-ordinated by the RCR Breast Group with Representatives from CMRI, Hull and Departments of Radiology at Newcastle, Luton and Dunstable, Aberdeen, and Brighton

PURPOSE: To determine if MRI can accurately predict pathological status of *de novo* architectural distortion and hence reduce the biopsy rate. METHOD: 23 patients, mean age 51 (range 35–72), with mammographic lesions characterized by multiple elongated spicules, or minimal central opacity, who were scheduled for open biopsy within 30 days, were recruited. MRI was performed using either multiple 3D acquisitions (temporal resolution 90 s) if the lesion was undetectable pre-contrast, or by fast dynamic imaging (temporal resolution 12 s) at pre-selected slice location for recognizable abnormalities. Pulse sequences varied slightly according to field strength and manufacturer. Lesions were analysed according to morphology, pattern of enhancement, percentage enhancement at 90 s and at maximum signal intensity and maximum intensity time ratio (MITR). The results obtained were compared with histopathology. RESULTS: Complete examinations were obtained in 22 out of 23 patients, of whom seven had malignant and 15 benign lesions. Although there was significant overlap between groups, the mean percentage enhancement at 90 s for radial scars/complex sclerosing lesions was significantly less than for tumours (25.0 ± 30.3 *vs* 51.9 ± 23.0; $p=0.05$). No difference was demonstrated for percentage enhancement at maximum signal intensity or MITR. CONCLUSION: Although there was considerable overlap in pattern of enhancement between benign and malignant causes of *de novo* architectural distortion, a cut of value of 25% enhancement at 90 s would prevent unnecessary biopsy in 60% of benign lesions, whilst detecting all tumours.

1050

Assessment of several quantitative measurements of dynamic contrast enhanced MRI in the differentiation of primary breast tumours

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PURPOSE: To examine the effectiveness of various methods of manual quantitation of dynamic contrast enhanced MRI in the differentiation of breast masses. MATERIALS AND METHODS: A total of 60 women were examined using a 1.5 T GE Signa system. Localizing images were followed by T_1 weighted dynamic images using an FSPGR sequence and T_1 weighted 3D FSPGR sequence with fat saturation. For the dynamic study, four sections covering the suspect lesion were selected. 25 images were acquired at each position during Gd-DTPA injection, with a temporal resolution of 12 s. Regions of interest were drawn around the lesions and mean values of percentage enhancement at each time-point calculated. Values for the maximum percentage enhancement, the time-to-maximum and the maximum intensity time ratio (MITR), which considers the temporal behaviour of the signal intensity changes, were calculated. RESULTS: 30 benign and 30 malignant lesions were examined, with either a histopathological diagnosis or a 2/3 year clinical follow-up available. Maximum percentage enhancement was marginally greater in malignant lesions, but this was not significant ($p=0.9$). Percentage enhancement was greater in malignancy up to 232 s, but significant differences were only observed from 61 s to 85 s ($p<0.02$). Values of MITR were greater in malignant lesions and this difference was highly significant ($p=0.005$). CONCLUSIONS: Of the measurements examined, MITR is most effective in discriminating benign and malignant lesions. The results also suggest optimum time points for differentiating breast lesions. On-going work will examine tissue characterization beyond a 5 min time course.

1100

Correlation of maximum tumour enhancement on dynamic MRI of the breast with histological prognostic factors

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PURPOSE: Maximum tumour enhancement on dynamic contrast-enhanced MRI has been proposed as a predictor of axillary node status in invasive breast cancer. This study correlates maximum

tumour enhancement of MRI with histopathological tumour size, grade and the presence of lymphovascular invasion, also recognized prognostic indicators. MATERIALS AND METHODS: 26 tumours from 24 patients, aged 33–78 years (mean = 54 years), with invasive breast cancer were imaged pre-operatively using dynamic contrast-enhanced MRI on a 1.5 T Philips ACS scanner. Region of interest analysis was performed on dynamic contrast-enhanced images of the tumour, calculating the maximum enhancement ratio (MER) (the maximum increase in mean pixel signal intensity relative to pre-contrast T_1 weighted images). The MER of each tumour was correlated with histological size, grade and presence of lymphovascular invasion, following wide local excision or mastectomy. RESULTS: There was a wide range of MER (0.9–3.6). Tumours were in the range 12–40 mm (mean = 21.2 mm). There were four Grade 3 tumours, 20 Grade 2 and two Grade 1 tumours. Lymphovascular invasion was noted in 14 tumours. Correlation was low between MER and histological grade ($r = 0.37$) and between MER and maximum tumour diameter ($r = 0.31$). There was no statistical difference between the MER for patients with and without lymphovascular invasion ($p = 0.44$). CONCLUSION: The preliminary findings of this ongoing study suggest that the degree of tumour enhancement on dynamic-enhanced MRI is unreliable as a prognostic factor compared with histopathologic determinants.

1110

Does a single MRI examination in breast cancer follow-up predict clinical outcome?

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PURPOSE: To evaluate whether a single MRI examination in follow-up post breast-cancer surgery is a useful predictor of clinical outcome. METHOD: 63 post-surgical patients from the breast cancer follow-up clinic were referred for breast MRI between October 1993 and September 1994. All had bilateral dynamic contrast-enhanced T_1 weighted FLASH sequences at 60–90 s intervals. Clinical outcome at 3 years was established from case-note review and correlated with MRI findings. RESULTS: Follow-up was available in 59/63 patients (median 36 months: range 10–47 months). 26/59 had been referred because of clinical or mammographic uncertainty. MRI findings were equivocal in 4/26; all were subsequently confirmed as benign disease. 24/26 were well at follow-up, but 2/26 developed symptomatic metastases at 19 and 35 months, respectively. 33/59 patients without diagnostic uncertainty were referred for MRI and formed a control group. Unsuspected disease was detected in 1/33 (pleural metastases). 32/33 examinations showed post-operative changes only. Three of these patients subsequently developed local recurrence at 21, 25 and 29 months post-MRI. CONCLUSION: Breast MRI is helpful in assessing the diagnostically difficult, post-operative breast. However, absence of recurrent disease is a poor predictor of outcome at 3 year follow-up. There is no place for a single "screening" MRI examination in the post-surgical patient.

1120

The value of colour and power Doppler in the differential diagnosis of solid breast tumours

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PURPOSE: The purpose of the study is to evaluate if colour Doppler (CD) and power Doppler (PD) contribute to conventional US and to determine characteristics which may predict malignancy. METHODS: We prospectively examined 157 patients presenting with palpable or mammographic solid breast masses. The parameters documented were: grey scale diagnosis, defined as probably benign or malignant; number of vessels seen on CD and PD; vessel distribution and morphology. The likely diagnosis after evaluation with PD was also documented. RESULTS: 167 masses were examined and diagnoses confirmed with needle biopsy. There were 106 cancers and 61 benign masses. PD demonstrated vessel flow absent on CD in 31 lesions; 16 of these were cancers showing more than two vessels and/or abnormal vessel morphology. PD also correctly altered the diagnosis from probably benign to malignant in 13 cases; six of these were smaller than 10 mm in size. Features significantly associated with malignant lesions were: penetrating or central vessels (sensitivity 67%, specificity 75.4%, PPV 82.6%), tortuous vessels (sensitivity 51.9%, specificity 95% and PPV 94.8%) and branching vessels (sensitivity 26.4%, specificity 95% and PPV 90.3%), more than four vessels on PD (sensitivity 33.2%, specificity 86.9%, PPV 81.8%). Malignant tumours of high histological grade were more likely to demonstrate more than two vessels ($p = 0.008$) and branching vessels ($p = 0.09$) on PD. CONCLUSION: PD was superior to CD in the detection of vessel flow and vessel morphology, which appear to be specific indicators of malignancy.

1130

US-guided core biopsy of suspicious mammographic calcifications using high frequency and power Doppler US

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PURPOSE: The pre-operative diagnosis of suspicious mammographic microcalcifications usually requires stereotaxic needle biopsy as they are not visible using conventional US. This study aimed to see if high frequency US and power Doppler (PD) can aid detection and biopsy of microcalcification. METHODS: We prospectively performed high frequency US (13 MHz) and PD on 35 consecutive patients presenting with suspicious microcalcifications, in the absence of mammographic or palpable mass, which required needle biopsy. The presence of any US abnormality and abnormal flow pattern on PD was documented. US-guided core biopsy (USCB) was performed where possible. Stereotaxic biopsy was performed when US-guided biopsy was unsuccessful. RESULTS: Of 35 patients, 32 (91%) had US abnormalities corresponding to mammographic calcification. Two cases could not be imaged due to the depth of calcification. 21/28 USCB obtained a definitive result (75%). The absolute sensitivity for malignancy using US-guided biopsy was 81% (17/21). US-guided biopsy correctly identified invasive disease in 10/16 (62.5%) cases. Abnormal flow on PD did not discriminate between benign and malignant abnormalities. However, the presence of focal flow on PD was useful in directing successful biopsy in eight cases. Two invasive cancers in larger areas of ductal carcinoma *in situ* (DCIS) were detected using power Doppler and successfully biopsied. CONCLUSION: The combination of high frequency US with PD is useful in the detection and guidance of successful US-guided biopsy of microcalcification, particularly in the detection of invasive foci in areas of DCIS.

1140

Image-guided breast tumour excision in an interventional MRI unit

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PURPOSE: Interventional magnetic resonance (IMR) units produce unique opportunities for image-guided tumour surgery. Fast pulse sequences updating the image every 1.5 s allow "real-time" scanning to monitor the progress of resection. One potential advantage is confirmation of complete tumour excision. We assessed the potential of IMR for image-guided breast surgery. MATERIALS AND METHODS: 22 patients (range 19–70 years) with palpable tumours (21 benign by standard criteria and one breast carcinoma) underwent surgery under general anaesthesia in a 0.5 T IMR unit. Lesions were localized with contrast enhanced (gadolinium DTPA, 0.2 mmol kg^{-1}) fast spoiled gradient sequences (FSPGR) and pre-operative "real-time" fast gradient sequences. A fat-suppression Dixon subtraction technique was also used to localize two lesions. One simple mastectomy and 21 excision biopsies were undertaken in the IMR, using titanium instruments and an ultrasonic scalpel with intraoperative real-time imaging to demonstrate resection margins. FSPGR and real-time images were obtained at the end of the procedure to confirm complete excision. The Dixon sequence was used to assess resection in four patients. RESULTS: All tumours were visualized with static and real-time imaging and enhanced with contrast. Intraoperative imaging demonstrated a resection margin in all cases and post-procedure scans clearly demonstrated complete excision. The Dixon sequence was also useful in confirming excision. There were 15 fibroadenomas, two foci of sclerosing adenosis, one Schwannoma, one lymph node, one post-surgical scarring, one unexpected carcinoma and one advanced ductal carcinoma (these two enhanced in <2 min). CONCLUSION: This study represents the first reported series of breast surgery within an IMR unit. Intraoperative MRI scanning reliably identifies palpable breast tumours, demonstrates the resection margin and confirms complete excision of the tumour. Further work can now be performed using intraoperative MRI to guide breast-conserving surgery for malignant lesions and localization of impalpable lesions.

1030–1200
Scientific Session
Musculoskeletal Trauma 2
Hall 11a

1030
Invited Review
Is CT scanning of C1–2 in a trauma environment justified as a first line investigation?
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A study is being undertaken at the Royal London Hospital (RLH) to assess whether routine CT scanning of the craniocervical and atlanto-occipital levels in major trauma patients is justified as a first-line investigation. The study is to consist of 100 patients admitted via the Trauma Room, with mechanisms of injury indicative of potential acute cervical trauma, but in whom a clinical evaluation is not possible due to altered mental status. A plain film trauma series is performed on all patients. At the RLH, trauma obliques are routinely imaged in conjunction with a lateral. These views, however, are not useful in determining injury at the craniocaudal and atlantoaxial levels. Advanced Trauma Life Support guidelines suggest anteroposterior and odontoid peg views are required to exclude upper cervical spine injuries, but these views cannot be adequately performed in intubated trauma patients. Recent literature suggests the scanning of these levels will detect a significant number of unsuspected injuries. If these injuries are found to be clinically significant and have an impact on patient management, then the additional time and cost to the department and the increased radiation dose to the patient will be justified. Data is being collected, both concurrently and retrospectively, and the results of plain films are compared with the CT findings. The initial impact of the findings is particularly important in immobilization of the patient, or the need for further diagnostic imaging tests. The study also aims to correlate abnormalities on CT with the patients' injury severity score (ISS), or Glasgow coma score (GCS).

1100
The paediatric skeletal response to internal fixation
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The paediatric skeleton differs in many respects from that of the adult. Despite its greater capacity for healing and remodelling, internal fixation is still required in many circumstances. It is currently our policy to remove most of these implants after a short period because of possible long-term effects. All children also have post-operative radiographs to plan subsequent protection and for perceived medico–legal issues. To assess the response of the paediatric skeleton to these implants we reviewed 110 children following removal of internal fixation. These implants were placed for various acute and chronic conditions. The case histories and radiographs were reviewed to assess the difficulty in removing the implant, the post-operative morbidity and radiological appearances. Four of the implants were considered difficult to remove. There was one refracture (0.91%), a lower level than in adult studies. We found a significant difference in the degree of cortical assimilation of the implant depending on its type. Semi-tubular plates resulted in significantly less cortical indentation (7.3%) when compared with dynamic compression plating (41.6%), regardless of implant site ($p<0.01$, Wilcoxon unpaired). The degree of indentation was greater the longer the implant was *in situ*. It appears that children have a variable capacity for cortical assimilation of internal fixation devices depending on the nature of the implant and, not unexpectedly, its length of time *in situ*. This may have implications on removal if implants are retained for long periods. Children also have a lower morbidity than adults following implant removal.

1110
Imaging of the problem scaphoid
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PURPOSE: Scaphoid fractures can be difficult to diagnose on routine radiographic views at the time of injury or even 2 weeks after the event. Early diagnosis is necessary for adequate and correct management to be undertaken for scaphoid fractures. This study will determine the most beneficial imaging technique for clinically-suspected scaphoid fractures, where plain radiographic views are normal. METHOD: A prospective study of 20 patients with clinically suspected scaphoid fractures was undertaken. All patients had standard, four view X-rays of the scaphoid, both at the time of injury and 2 weeks later. All 20 patients had an MRI scan and a radionuclide bone scan within 2–4 weeks after the injury. Further X-rays at 8 weeks were also undertaken. RESULTS: Of the 20 patients studied, six had no bony injury either on MRI or radionuclide bone scans, three scaphoid fractures were found both on MRI and on radionuclide bone scanning. There was one fractured scaphoid diagnosed on radionuclide bone scan which was negative on the MRI scan and on plain films done at 8 weeks. Various other pathologies were also detected. CONCLUSIONS: MRI gives most information and is the nearest technique to a "gold standard" that exists. If the MRI scan of the wrist can be performed at 2 weeks, then this imaging technique will direct the orthopaedic surgeon to the most appropriate management of a group of patients with a difficult diagnostic problem relating to scaphoid injuries.

1120
Femoral neck fractures: an outcome analysis
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Femoral neck fracture is a common clinical problem with a high mortality. We undertook a retrospective study of all femoral neck fractures admitted to an orthopaedic trauma centre over 1 year to assess the predictors of mortality. The study included 249 patients [45 male (18%), 204 female (82%)], with a mean age of 80.8 years (range 43–100 years). Fracture type comprised 133 intracapsular (IC) (53.4%), 107 intertrochanteric (IT) (43%) and nine subtrochanteric (ST) (3.6%). Operative intervention was undertaken in 233 patients (IC 124/133, IT 101/107, ST 8/9). There were 34 orthopaedic deaths. (13.4%)—IC 15/133 (11.3%), extracapsular 19/116 (16.4%). Sex-related mortality comprised 12/45 male (26.6%) and 22/204 female (10.7%) ($\chi^2=7.88$ $p<0.01$). The mean age of those who died (85.9 years) was significantly higher than those alive (80 years) (*t* test, $p<0.0001$). An additional associated fracture (all involving the upper limb) also resulted in significantly higher mortality (5/12) ($\chi^2=6.05$, $p<0.02$). Previous studies have shown the association of mortality with age, sex and length of stay. An additional associated fracture as a significant predictor of mortality has not been previously described.

1130
The use of cross-sectional imaging in chronic ankle conditions and its influence on management
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PURPOSE: To investigate the referral pattern of patients with chronic ankle conditions who underwent CT or MRI in our hospital. We looked at the spectrum of conditions imaged and, by patient follow-up, assessed whether the imaging influenced their clinical management. MATERIALS AND METHODS: A study was undertaken of 59 patients with chronic ankle conditions referred for cross-sectional imaging between 1993 and 1996. Images were scored for abnormality and details of the patients' histories and subsequent management obtained. RESULTS: The majority of patients were found to be suffering from pain and functional instability following previous trauma (inversion injury or fracture). The severity of image findings did not correlate with patient symptoms, clinical findings or subsequent management. Management was found to be more closely associated with clinical findings. CONCLUSION: We propose an algorithm for the more efficient use of imaging in management of chronic ankle conditions, with a bias towards patients whose clinical situation indicates the need for surgical intervention.

1140
Accuracy of CT, MRI and radiography in orbital floor fractures and tissue prolapse: endoscopic correlation
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PURPOSE: Although it has been suggested that MRI is superior to CT for the detection of soft tissue prolapse in orbital floor fractures, there are few previous studies correlating the accuracy of CT and MRI, in the diagnosis of all types of fracture of the orbital floor and soft tissue herniation into the maxillary sinus, with the operative findings. The purpose of this study was to investigate the accuracy of CT, MRI, plain radiographs and clinical signs in the diagnosis of these injuries, using maxillary sinus sinuoscopy

as the "gold standard". MATERIALS AND METHODS: 37 consecutive patients with orbital trauma were prospectively investigated with CT (37 patients), MRI (16 patients), plain radiographs (32 patients) and maxillary sinus sinuoscopy (37 patients). In 26 patients surgical correlation was also obtained. The radiological and clinical assessments were undertaken independently. RESULTS: CT had a significantly greater sensitivity and overall accuracy for the detection of orbital floor fractures (both 100%) than MRI (both 75%) and plain radiographs (both 6%). Similarly, CT had a significantly greater sensitivity and overall accuracy (79%; 81%) for the detection of orbital soft tissue prolapse than MRI (45%; 63%) and plain radiographs (9%; 34%). CONCLUSIONS: We found CT to be more reliable than MRI and plain radiographs for the detection of orbital floor fractures and demonstrated a greater accuracy than previously reported in showing orbital soft tissue prolapse into the maxillary sinus.

1150
Managing head injuries in District General Hospitals: assessing criteria for repeat cranial CT scans
A Hardy, D Nag and M Bodhe
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PURPOSE: To assess critically radiological and clinical criteria for re-scanning patients being managed outside a neurosurgical unit and to correlate with outcomes. PATIENTS AND METHODS: Details of all patients undergoing repeat CT scans within an interval of 1 week from the original scan were analysed and their clinical and radiological findings matched. Final outcomes were plotted and the data compared with evidence of current UK practice from published literature. RESULTS: Over a period of 4 years, out of a total of 340 patients, 37 (11%) underwent repeat cranial CT scans within a week. This allowed objective evidence of improvement or deterioration to be documented and communicated to the neurosurgical unit to enable decision-making. 30% had skull fractures, 41% contusions and 39% subdural haematomata. Over 50% had evidence of more than one finding representing intracranial injury. The vast majority of repeat scans showed improvement and provided re-assurance, with good correlation with clinical progress. In six patients, the initial CT scan showed no evidence of intracranial injury, although five had fractures, and the repeat CT scans remain unchanged. In one patient with diffuse axonal injury, repeat CT scans confirmed lack of improvement and was a prognostic indicator. CONCLUSION: Strict clinical criteria are required for re-scanning patients with no evidence of intracranial injury on the initial scan. In those with small contusions only, a degree of restraint may also be justified in the face of good clinical progress.

1045–1235
Scientific Session
Interventional Radiology 2
Hall 1

1045
Invited Review
Interventional radiology in the chest
R W Günther
Department of Diagnostic Radiology, University Hospital, D-52074 Aachen, Germany
Interventional radiology offers a large variety of vascular and non-vascular thoracic interventions including: PERCUTANEOUS BIOPSY: Percutaneous fine needle biopsy, performed under fluoroscopic or CT guidance, is a standard technique for the diagnosis of unclassified focal lung lesions. Its sensitivity is in the range 89–98%, with a specificity of 87–97% and a complication rate of 9–41%. In diffuse lung disease, percutaneous biopsy is very rare. PERCUTANEOUS DRAINAGE: Simple aspiration (thoracocentesis) or drainage using small chest tubes combined with a Heimlich valve are very effective in post-biopsy pneumothorax. Pleura empyemas may also be treated under radiographic guidance, with a cure rate of 75–92%. CT-guided drainage is particularly indicated in empyemas in difficult locations, but relatively contraindicated in multiloculated empyema. In lung abscesses, CT-guided drainage may be recommended as a last resort. ENDOBRONCHIAL INTERVENTIONS: Stent placement is mostly used in malignant disease for palliation of stenoses. Its effect is only short-lived because of restenosis due to tumour growth through the meshwork of the stent. VASCULAR INTERVENTIONS: *Bronchial artery embolization.* Indication for embolization is intractable haemoptysis. Complications may occur in 0.6–1.6% of patients, with paraplegia being the most severe complication reported. Immediate bleeding control is obtained in 78–96% of patients. The rate of late recurrence is in the range 28–57%. *Embolization of pulmonary arteriovenous malformations (PAVM)* Indications for embolization are PAVM >3 mm in size. Embolizing materials used are coils and, less frequently, detachable balloons. The procedure is safe and highly effective, with about 90% of patients being cured or improved. *Angioplasty of pulmonary artery stenosis* has been successfully applied in a limited number of patients. *Percutaneous extraction of foreign bodies* is the technique of choice for removal of foreign bodies, such as broken catheters migrated into the right heart and pulmonary arteries. *Percutaneous management of pulmonary embolism (PE).* In severe and life-threatening embolism, percutaneous embolectomy, gross fragmentation using balloon catheters or angiographic catheters may be a measure of last resort to prevent acute right heart failure.

1115
Invited Review
Local thrombolysis and stenting in obstruction of large veins
R F Dondelinger and G Trotteur
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PURPOSE: To evaluate retrospectively the effectiveness of local thrombolytic infusion and metal stent placement in the treatment of obstruction of large veins. MATERIALS AND METHODS: 64 patients were included. 37 had a malignant tumour responsible for large vein obstruction, which was located in the superior vena cava (SVC) system in 20 cases and in the inferior vena cava (IVC) system in 17 cases. Local thrombolytic infusion using urokinase at a dose of 100 000 iu h^{-1} was given in seven patients for treatment of complete luminal obstruction before stenting. 27 patients presented with 29 stenoses of a benign origin; 22 were located in the SVC system and seven in the IVC system. Local thrombolytic infusion was administered in 14 patients. Wallstents and Gianturco stents were used in all patients. RESULTS: In malignant obstruction, patency was re-established in 29 cases (78%). Patients became asymptomatic until death. In five cases, clinical symptoms persisted, despite complete stent expansion. Delayed stent thrombosis occurred in two patients (5.4%). Three complications were noticed: haemoptysis, thrombus formation inside a stent and stent migration in the IVC. In benign obstruction, stent patency was achieved in 23 cases (82%), one case was a technical failure. Delayed stent obstruction occurred in four cases (14%) at 1, 2, 15 and 29 months, respectively. Stent fragmentation occurred in two stents placed in the subclavian vein. Another stent migrated from the subclavian vein to the pulmonary artery and was retrieved percutaneously. CONCLUSION: Local fibrinolytic therapy and stent placement are reasonable therapeutic alternatives for treatment of malignant and benign venous obstruction.

1145
Invited Review
The (b)leading edge: minimally invasive therapy centres for procedural medicine
S L Dawson
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By now, the fact that there has been a revolution in treatment for a variety of diseases is old news. Everyone knows about "belly button" or "keyhole" surgery: insurers encourage its use, physicians compete for patients by marketing their "less invasive" skills, and clinics sprout up for drive-in surgery. Yet, the current techniques have frequently been adopted without controlled clinical trials. Training in procedures which didn't exist during residency has been compressed into weekend animal courses that provide certificates testifying to an individual's proficiency. Outcomes of new techniques are only now being rigorously assessed, years after clinical introduction. Market surveys show that penetration of laparoscopic surgery has plateaued in most specialties. The question arises as to where the next generation of minimally invasive techniques will be developed—within the medical community or inside corporate marketing offices. At a few interdisciplinary centres around the world, teams of physicians are cooperating to leverage the synergies of collaboration. These centres will serve as "incubators" for creative physicians, engineers and scientists to develop technologies based upon clinical needs. Fully developed centres will incorporate imaging, surgery, endoscopy, interventional subspecialties and outcome groups. Collaborators will include government agencies, corporate R&D groups and basic scientists working under physician guidance. This lecture will highlight the efforts of some of these centres, with particular emphasis on the organization led by the speaker, the Center for Innovative Minimally Invasive Therapy at Massachusetts General Hospital.

1215

Inferior vena cava filters: a retrospective review of their use and associated complications

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PURPOSE: Following their introduction into clinical radiological practice, inferior vena cava (IVC) filters have remained controversial. This is in part due to a paucity of data available looking at the benefits and risks of using caval filters. METHOD: We undertook a retrospective review of radiologically inserted caval filters in our unit over a 5 year period. RESULTS: 24 patients, with a mean age of 54 years, underwent filter insertion. Indications for placement included eight filters for recurrent pulmonary emboli in the setting of full anticoagulation (two temporary and six permanent) and 12 for pulmonary emboli prevention during thrombolytic therapy (12 temporary and one permanent). Three temporary filters were deployed in pregnant women with proven iliac vein thrombosis and one to prevent tumour embolization. A total of 25 filters were deployed, with the mean insertion time for the temporary filters being 4.6 days. There were no complications of filter insertion. There was, however, one fatality during deployment as a result of a caval tear. Functional filter problems were seen in three individuals who continued to have recurrent pulmonary emboli. Follow-up revealed continuing survival in all patients with no underlying malignancy and in none of these was there evidence of clinically-detectable IVC thrombosis. CONCLUSION: IVC filters have a developing role in the prevention of pulmonary embolic disease. There are few recognized absolute indications for their deployment as their use is associated with complications.

1225

Caval filters: an under-utilized vascular intervention

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AIMS: Caval filters have a defined role in the management of thromboembolic disease; currently far fewer are inserted in the UK than in the USA or Europe. Our aim was to determine if caval filters have been under-utilized in our institution in which we insert on average only three per year. METHODS: A patient cohort deemed to have a possibility of benefit from caval filter insertion was identified by retrospective case-note study of those patients who died within 30 days of a ventilation–perfusion (V/Q) scan over a 24 month period, ending in September 1997. Analysis was conducted to determine the number of patients who fulfilled the recognized criteria for caval filter insertion, but did not undergo this intervention. RESULTS: 606 patients had 636 V/Q scans during this period and 52 patients died within 30 days of scanning. Complete information was available on 38 (73.1%) of this cohort who had a total of 39 V/Q scans, of which 14 were positive, 22 negative and three equivocal for the presence of pulmonary embolism (PE). Six (42.9%) patients with positive V/Q scans had strong indications for caval filter insertion. This group consisted of two men and four women, with a mean age of 71.2 years (range 46–84). Principle co-pathologies included disseminated malignancy in two, CVA in two, undisseminated malignancy in one and *de novo* PE in one. All patients were being actively managed and all died following PE, complication arising from PE, or anticoagulant therapy. CONCLUSION: During a 2 year period we have identified six patients whose deaths could have been possibly prevented by the insertion of caval filters. Our findings are consistent with the American and European experience of a more aggressive approach in the use of caval filters to prevent mortality due to PE and its management.

1045–1155 Scientific Session **Nuclear Medicine** Hall 11b

1045

PET imaging with a dual-headed gamma camera—initial experiences

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PURPOSE: True coincidence PET studies can now be performed on conventional double-headed gamma cameras with modified software and hardware. This significantly reduces the cost of PET imaging. Our unit is currently the only UK facility to offer this service. This presentation demonstrates our early experience in cancer imaging. MATERIALS AND METHODS: 24 patients have been studied to determine the benign or malignant nature of lesions demonstrated by other imaging techniques. Potential pathologies were as follows: pancreatic tumour (seven), cholangiocarcinoma (six), recurrent glioma (three), lung cancer (two), endometrial cancer recurrence (one), colorectal cancer metastasis (one), recurrent head and neck tumour (two), breast cancer (one). Scans were interpreted by visual inspection without resort to a quantitative technique. RESULTS: Nine positive scans were obtained: three pancreatic cancers, two cholangiocarcinomas, one lung cancer, one endometrial cancer recurrence, one colorectal cancer metastatic to nodes and liver, one head and neck tumour metastatic to clavicle. These cases will be illustrated with correlative imaging and histological or clinical confirmation. CONCLUSION: These are early data and, clearly, further follow-up and evaluation will be required to show the true clinical role of this form of PET imaging. It is recognized that resolution and count capabilities do not match those offered by dedicated PET scanners. However, these images have already proven to be of clinical value, altering management in several cases and resolving clinical problems. Dedicated PET facilities are not widely available due to the cost. This technique, using conventional modified gamma cameras, allows potentially any hospital with a nuclear medicine facility to perform PET imaging.

1055

PET imaging with the Picker gamma camera PCD system

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There has recently been a surge of interest in imaging positron-emitting isotopes with dual-headed gamma cameras converted to operate in coincidence mode. This presentation discusses the performance characteristics of one such system, the importance of the acquisition parameters and reconstruction methodology, and the efficacy of clinical imaging with ^{18}F deoxyglucose (^{18}FDG). The acceptance tests closely followed the NEMA standard published for dedicated PET scanners. The key results were 5 mm resolution (FWHM) over the field of view, 9% energy resolution (FWHM) and a NEMA sensitivity of 0.6 cps Bq^{-1} cm^3 and 4.1 cps Bq^{-1} cm^3 measured with and without septa, respectively. Noise equivalent count rate analysis has been used to optimize the acquisition mode (septa and energy window) and activity level for brain and thorax imaging. The initial conclusions of this analysis indicate that a 20% photopeak window is optimal and that septa should be used for thorax imaging, but not for the brain. The 2D reconstruction algorithm supplied with the system has been compared with an in-house 3D algorithm with respect to data utilization, resolution and noise characteristics. The 3D algorithm produces superior results, particularly when the septa are omitted, but is more computationally expensive. The efficacy of corrections for attenuation, scatter, randoms and pile-up will be demonstrated. The presentation ends with examples of ^{18}FDG oncology and neurology studies performed with the system.

1105

The significance of pulmonary hot spots in routine white cell scintigraphy

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An early posterior chest view is often used to assess *in vivo* white cell (WBC) viability in patients undergoing ^{99}Tc^m or ^{111}In WBC scintigraphy. A retrospective analysis from a series of 69 consecutive patients studied over a 3 month period, in whom lung pathology was not implicated, showed that lung hot spots commonly occurred. PURPOSE: To assess the frequency and implications of pulmonary hot spots for WBC image interpretation and to pinpoint the causative factors. METHOD: White cell viability was verified by the appearance of the relative uptake of liver compared with spleen and general lung clearance. All images were scored (0–3) according to the number of hot spots within the lung field (0=no hot spots; 3⩾three hot spots). RESULTS: In all 69 patients, lung clearance was rapid and the visual appearance of liver and spleen was as expected. Of 48 studies performed with ^{99}Tc^m WBC, 25 showed unexpected uptake in the pulmonary bed, with one or more hot spots. For ^{111}In WBC; of 21 studies, three showed uptake, each with only a single hot spot. CONCLUSION: Although many possible causative factors were examined and excluded, including time from finish

of labelling to re-injection, transport, labelling technique (which includes a lysis step to remove red cell contamination) and injection technique, no single factor could be implicated. Pulmonary uptake may frequently occur in WBC scintigraphy which, although not affecting viability, may interfere with the demonstration of altered lung pathology.

1115

Role of P-glycoprotein in $^{99}Tc^m$ sestamibi imaging for the detection of breast cancer

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$^{99}Tc^m$ sestamibi has been used successfully for imaging tumours, especially malignant tumours of the breast, with a reasonably high rate of success. $^{99}Tc^m$ sestamibi also acts as a P-glycoprotein (Pgp) substrate and is therefore extruded from the Pgp-positive tumour cells, like anticancer drugs which share a common mechanism of multidrug resistance. We studied 10 patients with histologically-proven palpable breast cancer, to test the hypothesis that the presence of Pgp may lower the sensitivity of $^{99}Tc^m$ sestamibi for breast imaging. Tumour samples were also tested immunohistochemically, using monoclonal antibodies C494 and C219 for the presence of Pgp. Prone, lateral and anterior images were acquired 20 and 120 min after 440 MBq of $^{99}Tc^m$-sestamibi given iv in the contralateral arm. 3/10 tumours were not visualized (false negative) and two of them were positive for Pgp. 4/10 showed significant reduction in tumour to background ratio at 120 min as compared with 20 min, all of these were positive for Pgp. 3/10 showed no significant change at 20 and 120 min, all three were negative for Pgp. CONCLUSION: This study suggests that the presence of Pgp in a breast tumour is an important marker, which can predominantly lower the sensitivity of $^{99}Tc^m$ sestamibi imaging and may predict drug resistance to anticancer treatment.

1125

$^{99}Tc^m$ MIBI scintimammography in suspected recurrent breast cancer

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PURPOSE: To assess the accuracy of both $^{99}Tc^m$ MIBI scintimammography and X-ray mammography in identifying locoregional recurrence of breast cancer. METHODS AND MATERIALS: A prospective trial was performed on 19 patients (mean age 59, range 46–79 years) with suspected recurrent breast cancer. Three patients had undergone mastectomy (one bilateral), so that a total of 34 breasts were studied with X-ray mammography and prone–lateral and anterior scintimammography. These were reported as normal, equivocal or positive for recurrent cancer. Any additional local or nodal uptake of $^{99}Tc^m$ MIBI was noted. Clinical confirmation was by pathological examination of tissue samples, correlative imaging and clinical follow-up. RESULTS: 12 patients were found to have loco-regional recurrence of breast cancer and in all patients the $^{99}Tc^m$ MIBI scintimammography was either abnormal in the breast or in loco-regional tissue. Nine breasts had recurrent cancer in eight patients. X-ray mammography identified seven of these cancers. $^{99}Tc^m$ MIBI scintimammography identified eight. The accuracy of $^{99}Tc^m$ scintimammography within the breast (81%) is similar to X-ray mammography (84%). Extramammary loco-regional recurrence was identified in five out of six patients with $^{99}Tc^m$ MIBI. CONCLUSION: $^{99}Tc^m$ scintimammography identified all patients with loco-regional recurrence, but only 42% of these patients had abnormal X-ray mammography. $^{99}Tc^m$ MIBI scintimammography is therefore recommended in patients with suspected loco-regional recurrent breast cancer.

1135

Discordance between ^{67}Ga SPECT scintigraphy and CT in follow-up of lymphoma patients

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Departments of [1]Radiology, [2]Nuclear Medicine and [3]Haematology, Hadassah University Hospital, Jerusalem, Israel

In patients with lymphoma, CT and ^{67}Ga SPECT scintigraphy (^{67}Ga) are used routinely to assess patients' outcome. Discrepancy between the results of these studies may cause confusion. We performed a cohort study between January 1994 and December 1996 of all lymphoma patients in an attempt to find the prevalence and characteristics of discrepancy noted during disease follow-up. Non ^{67}Ga avid cases at presentation were excluded. Discrepancy was defined as the documentation of contradictory findings on CT and ^{67}Ga. End-points for eventual outcome were defined as either clinical remission or disease activity. Of 132 patients with lymphoma, discrepancy was confirmed in 18 (14%). It was 32% in Hodgkin's lymphoma patients (13/41) and 5% in non-Hodgkin's lymphoma patients (5/91). The mean follow-up was 22 months (range 6–46). In nine patients a positive ^{67}Ga and a negative CT was found and only one of these patients had subsequent disease. In eight patients a positive CT was accompanied by a negative scan, and four of these subsequently had active disease. One patient had equivocal findings on both CT and ^{67}Ga. Discrepancy was seen in the regions of the mediastinum, lungs, spleen and kidneys. We conclude that discrepancy is not rare (14%), especially among Hodgkin's lymphoma patients (32%). Only five of the 18 patients with discrepancy eventually relapsed so it appears that an expectant policy with repeated studies is warranted. When a positive CT is accompanied by a negative ^{67}Ga, more suspicion of clinical activity might be warranted.

1145

Positron emission tomography is useful in assessing axillary lymph nodes in breast cancer

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PURPOSE: The single most important prognostic factor in breast cancer is axillary node involvement by tumour. Determination of regional lymph node involvement requires axillary dissection, resulting in additional time in hospital and post-operative morbidity. A reliable, non-invasive method of determining axillary node status would be valuable. Positron emission tomography (PET) produces images based on the distribution and metabolism of administered positron-emitting compounds, so reflecting the functional, rather than anatomical, characteristics of the imaged tissue. PET may therefore allow identification of metastatic tumour in regional lymph nodes. MATERIALS AND METHODS: Patients with previously untreated malignant breast lesions had PET, using 105–185 MBq of 2-deoxy-2-(^{18}F)fluoro-D-glucose, of their axillae and upper thorax performed prior to surgery. Patients were clinically examined following PET. The accuracy of clinical and PET node staging was compared with node histology following surgical excision. RESULTS: 50 patients underwent PET imaging of their axillae. 21 had positive axillary nodes at histology: PET was positive in 19. 29 patients did not have any nodes involved at histology: PET was positive in one and negative in 28. Therefore PET had a specificity of 97% and a sensitivity of 90%. Clinical examination of the same patients had a specificity of 90% and sensitivity of 57%. CONCLUSION: PET has a high sensitivity and specificity for detecting axillary node involvement in breast cancer. It may be of use in the routine staging of breast cancer and obviate the need for axillary surgery in the majority of patients.

1100–1145
College of Radiographers
Presidential Address
Hall 9

1100

I'm (just) a radiographer!

D Hardy

College of Radiographers, 2 Carriage Row, 183 Eversholt Street, London NW1 1BU, UK

No abstract.

1100–1150
Scientific Session
Radiation Protection
Hall 10b

1100
An investigation of the relationship between image quality and entrance surface dose in neonatal chest radiographs

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PURPOSE: To compare entrance surface doses (ESD) in neonatal chest radiography in five special care baby units with the reference dose recommended by the European Commission (EC) and to investigate the effects of radiographic technique on image quality and ESD. METHOD: Radiograph and film processing systems were surveyed. A dose–area product meter was used with recorded exposure factors to calculate ESD. Image quality was assessed using modified EC criteria by one external radiologist and on each site by a local radiologist. RESULTS: No site met EC criteria for tube potential or additional filtration. The inter-quartile range of doses of all sites was below the EC reference dose of 80 μ Grays. There was a strong inverse relationship between ESD and actual speed of imaging system (correlation $= -0.95$, $p = 0.013$) without there being a similar relationship with image quality. There was an appreciable range of ESDs between and within sites. The reliability for measurement of image quality was 0.807 for the mean of two independent readers. The range of difference between nominal and actual speeds of film-screen processor systems varied by between $\times 2.13$ and $\times 6.26$. Two sites with significantly slower systems used dedicated processing units. CONCLUSIONS: EC image quality criteria are subjective, but with care can produce reliable results. Increase in speed does not lead to significant decrease in image quality, but is correlated with decrease in dose. To comply with ALARA the actual speed of individual systems must be measured at the energy used and those with low speeds must be investigated.

1110
Factors affecting patient dose in chest and lumbar spine examinations

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The recently revised Directive of the European Community, 97/43/Euratom, requires that member states establish procedures and written protocols to enable optimization of radiological practice, with particular reference to the implementation of clinical audit processes and the establishment of diagnostic reference dose levels for typical examinations for groups of standard patients. Complete fulfilment of the requirements of the Directive requires a planned development programme. At the moment it is not clear how the selection of radiographic technique is related to the final outcome of the examination, in terms of patient dose and adequate diagnostic information. To establish a suitable framework to enable the Directive to be implemented, it is necessary to understand how and in what way doses delivered to patients undergoing radiological examination can vary. It is also necessary to know how those variations affect the outcome (*i.e.* the radiological image and subsequent diagnosis) of that examination. It is worth noting that national surveys have clearly demonstrated the important role that film–screen speed plays in determining patient dose. The widespread introduction of rare-earth screens has lead to a roughly 50% reduction in doses measured recently, compared with earlier studies. This study examines the way film–screen sensitivity and grid transmission factor affect the distribution of patient dose for PA chest and AP lumbar spine examinations. The results of variation in film–screen sensitivity and grid transmission ratio will be presented and cross-correlated with the results from a patient dose audit of PA chest and AP lumbar spine examinations undertaken at a number of hospital sites in the Merseyside area.

1120
Patient radiation dose audit: reducing radiation doses and improving equipment performance

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PURPOSE: A system has been developed to analyse the data from dose area product meters, comparing the doses received by patients with the maximum recommended doses suggested by the National Radiological Protection Board. MATERIALS/METHODS: Dose–area product meters are fitted to many X-ray machines in radiology departments and are used to indicate the radiation dose received by patients. A software system has been developed to analyse the results from dose–area product meters for simple radiographic examinations, or more complex procedures, such as barium enema investigations. As well as comparing doses with the NRPB reference doses, it is also possible to compare them with those from other hospitals, or other X-ray rooms within a single hospital. RESULTS: One early benefit of this system was the discovery that two technically similar X-ray rooms in Southampton gave considerably different radiation doses for barium enema examinations. Measurements using a phantom confirmed the dose audit data and X-ray equipment engineers were asked to investigate the problem. They found two technical problems and effected remedial work. Subsequent measurements showed that the two rooms were now performing to similar standards and analysis of subsequent patient dose audit data has shown a considerable reduction in radiation doses in the previously higher dose room. CONCLUSION: A routine dose-monitoring system can detect deterioration in image system performance between equipment tests.

1130
Fetal distribution of pertechnetate and $^{99}Tc^m$-MAA-relevance to fetal radiation dose from lung scans in pregnancy

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PURPOSE: The nuclear medicine procedure most often required during pregnancy is lung imaging using $^{99}Tc^m$-MAA in diagnosis of pulmonary embolism. Estimates of the resultant radiation dose to the fetus have used the calculated uterine dose, but there are few data available on the fetal distribution of technetium and technetium-labelled radiopharmaceuticals, from which to accurately estimate dose and identify target organs in the fetus. We have determined fetal biodistribution of $^{99}Na^m$ pertechnetate and $^{99}Tc^m$-MAA in the guinea pig in late pregnancy. MATERIALS AND METHODS: $^{99}Na^m$ pertechnetate or $^{99}Tc^m$-MAA (7 MBq in 0.5 ml) were administered to guinea pigs in the 6th to 9th week of gestation (equivalent to the third trimester in humans). The maternal and fetal biodistribution of radioactivity was determined at intervals. RESULTS: Up to 3.5% of the administered activity of sodium pertechnetate accumulated in the fetus, with the highest specific activity found in fetal thyroid. Fetal thyroid activity was about 1.6 times that of maternal at both early and late time points after administration. In contrast, less than 0.1% of the administered $^{99}Tc^m$-MAA activity reached the fetus. Again, the highest specific activity was found in fetal thyroid, increasing with time after administration, suggesting that the activity transferred is in the form of unbound pertechnetate released by metabolism of the labelled MAA. CONCLUSION: These data have been used to estimate fetal isotope transfer following lung scintigraphy in late pregnancy and the resulting fetal radiation exposure. This suggests that risk to health in childhood after exposure to $^{99}Tc^m$ is very low.

1140
Mortality and morbidity study of veterans of UK nuclear weapons tests

S R Roff
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This paper reports the results of hypothesis-generating studies of a sample of 10% of men who were required to participate in UK nuclear weapons testing in the 1950s and 1960s. Data analysed indicate an accelerated rate of death from potentially radiogenic cancers among this cohort and evidence of an altered sex ratio in the children fathered by these men in precisely the 10 years of nuclear weapons testing, which suggests that they were exposed to ionizing radiation. The incidence of major birth defects seems highly elevated in children fathered after participation in the tests. A questionnaire-based morbidity study of the men and their families is in progress and results will be reported. These studies are intended to generate hypotheses for the secondary analysis of the two Standardized Mortality Ratio studies conducted by the National Radiological Protection Board under commission from the Ministry of Defence a decade ago, which proved inconclusive. Two cancers which all three studies (the two NRPB/MoD) studies and the present 1997 8 studies) have found to be elevated in this cohort are leukaemia and multiple myeloma. Recent data from the survivors of the bombings of Hiroshima and Nagasaki are compatible with the findings to date, with evidence of the necessity to revise our understanding of the latency of several radiogenic cancers, including meningioma. As

well as reporting significant information for the cohort of UK nuclear veterans, this research may be suggestive for cancer research in adults and children.

1200–1245
College of Radiographers
William Stripp Memorial Lecture
Hall 9

1200
Eponymous Lecture
The role of trauma oblique cervical spine radiographs in the seriously injured patient
B Tonello
Alex Wing X-ray, The Royal London Hospital, London, UK
The number of accident & emergency departments throughout the country which utilize ATLS protocols for trauma calls has increased dramatically. The ATLS X-ray trauma series is an accepted part of managing the seriously injured patient; however, the limitations of relying solely on the lateral c-spine radiograph may have serious consequences if any injuries are missed or further unnecessary imaging is pursued. The Royal London Hospital is the base for a Helicopter Emergency Medical Service which covers all the London area within the M25. As such, the emergency room sees a large number of polytraumatized patients with severe injuries. In this environment the potential role of the trauma oblique cervical spine radiograph was raised as an aid to the radiologists who were being asked to judge whether the cervical spines were clear of injury. This lecture will review the issue surrounding the use of trauma obliques and will also consider whether they may potentially have a role in replacing the swimmer's view as the projections of choice if the cervico–thoracic junction is not demonstrated.

1200–1245
Refresher Course
Minimum Standards for Quality in Diagnostic Imaging
Hall 10b

1200
Invited Review
Minimum standards for quality in diagnostic imaging
A P Jones
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In 1990, the report of the RCR and the NRPB entitled *Patient Dose Reduction in Diagnostic Radiology* gave valuable renewed publicity to many issues of dose reduction. Following this publicity, two important further documents have been published. The first arose from a joint working party of the IPEM and NRPB and provided a *National Protocol for the Measurement of Patient Doses in Diagnostic Radiology*. This report provided reference values for doses arising from common X-ray examinations, against which departments could assess their performance. The second and most recent document *Recommended Standards for the Routine Testing of Diagnostic X-ray Imaging Systems*, produced by a joint working party of the IPEM, the CoR and the NRPB, provides definitive advice on quality control testing. The document defines remedial levels at which point a formal assessment of the equipment's performance and of the risk arising from its continued use is required. These two documents effectively form the basis of a definition of a minimum standard for quality. Equipment performance is now constrained by the remedial level definitions. Direct measurement of samples of patient doses and comparison with what will become evolving reference values, will act as an overall marker for performance of both equipment and radiographic technique. When these aspects are taken in conjunction with the continuous assessment of images by radiographers and radiologists through viewing and reporting, there exists a system for the assessment and constant improvement of quality in diagnostic radiology.

1210–1300
Scientific Session
Spine MRI
Hall 11a

1210
The influence of lumbar spine MRI on the management of patients with low back pain
[1]J J Rankine, [2]K P Gill, [1]C E Hutchinson, [2]E R S Ross and [2]J B Williamson
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PURPOSE: To investigate the influence of lumbar spine MRI on the management of patients with low back and leg pain. METHODS: Lumbar spine MRI was performed on 72 patients with signs and symptoms suggestive of nerve root compression who were possible candidates for surgery. The patients were then assessed by one of two consultant orthopaedic spine surgeons without knowledge of the results of the MRI and without seeing the hard copy images. A diagnosis and a management plan was recorded. The clinician was then allowed immediate access to the report and the hard copy films and a revised diagnosis and management plan was recorded. RESULTS: The diagnosis remained unaltered in 50% of patients following MRI. The single largest change in diagnosis was in 13 patients where a clinical diagnosis of neural compression due to disc prolapse was revised to simple degenerative disc disease following MRI. A clinical diagnosis of central canal stenosis in seven patients was confirmed in only two cases. The number of patients with a surgical management plan fell from 48 (66.7%) to 31 (43.1%), whilst the numbers treated conservatively rose from 17 (23.6%) to 41 (56.9%) following MRI. Lumbar spine fusion was planned in seven patients for spondylolisthesis and in three of these patients the diagnosis was not suspected before MRI. CONCLUSION: Over half the patients undergoing MRI for suspected neural compression are subsequently treated conservatively. The reasons for this are discussed.

1220
Variations in the MRI assessment of the AP diameter of the lumbar spine canal
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PURPOSE: To assess variation in measurements of the AP canal diameter of the lumbar spine on MRI. METHODS: 20 MRI data sets (13 at 1.5 T; 7 at 0.5 T) were randomly selected from patients referred for lumbar spine imaging (sagittal T_1 weighted spin echo and T_2 weighted fast spin echo images). In each patient AP dimensions were measured at three anatomical levels (L3, 4 and 5) on an independent work-station by electronic calipers. Measurements were made on both sequences by three independent observers (A: medical student, B: specialist registrar C: consultant) on two occasions. Window levels were standardized as far as possible for MRI. Mean differences were calculated to assess intraobserver variation. As there is no "gold standard" measurement, an iterative gradient-based Newton approach was used to provide an appropriate "value" for each measurement. This allowed measurements of standard deviations of the "errors" for the three observers. RESULTS: Differences between T_2 weighted and T_1 weighted measurements (same level, same observer) ranged from $+3$ to -3 mm (mean 0.17 mm, T_2 weighted $> T_1$ weighted). For intraobserver variation, initial measurements were slightly lower than the second (range $+3$ to -4 mm, mean value -0.38 mm). With interobserver variation, the maximum mean standard deviations of the fixed "error" for the three observers were: A: 0.87 mm, B: 0.98 mm, C: 0.94 mm. CONCLUSION: MRI measurements of AP canal diameter are probably only accurate to ± 2 mm, regardless of the experience of the observer. Such discrepancies could lead to serious errors, especially in the assessment of narrow canals.

1230
Reproducibility of reporting of vertebral end-plate marrow signal changes on MRI
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INTRODUCTION: MRI is a common investigation in the management of chronic backache. Vertebral end-plate marrow signal alterations are being increasingly reported on and have been associated

with disc degeneration, increased functional disability and symptoms, in terms of pain. The observer is an important source of measurement error and reliability studies need to assess the level of observer variability in the measurement procedures used in data acquisition. AIM: To determine the interobserver and intraobserver variation in the reporting of vertebral end-plate marrow signal changes on MRI. METHOD: A set of T_1/T_2 weighted sequences from randomly selected patients with back pain was interpreted independently by two consultant radiologists specializing in musculoskeletal imaging and two consultant orthopaedics surgeons with a special interest in spinal disorders. They reported on the presence of marrow signal alterations, if any, on either side of the discs between L1 and S1, and the morphology grade of the observed signal change as defined by the authors. This exercise was repeated after 3 weeks. Interobserver and intraobserver variation in reporting was measured using κ statistics. κ was used to assess the interobserver agreement between orthopaedic surgeons and radiologists and the intraobserver agreement for each assessor. Percentage agreement, a non-probabilistic descriptor, was also calculated. A PC-based statistical package for the social sciences (SPSS) was used for analysis of the data. CONCLUSIONS: There was substantial intraobserver agreement for all the observers, observers in the southwest and between radiologists and orthopaedic surgeons. The major area of disagreement involved differentiating increased signal intensity from normal and signal changes with lower morphological grades.

1240
MRI in the evaluation of suspected spinal cord compression in malignant disease
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AIM: In malignant disease MRI is the imaging technique of choice for suspected spinal cord compression. The identification of multiple areas of involvement may influence the decision between surgery or radiotherapy and help in the positioning of radiation ports. This study examines the spectrum of disease occurring within the spinal canal in this patient group. METHODS: All patients were examined using a 1.0 T magnet (Siemens Impact) and a phase array surface spinal coil. Sagittal T_1 weighted spin echo and STIR sequences were routinely employed, with axial T_1/T_2 weighted images performed at levels demonstrating compression. RESULTS: A total of 92 patients were examined over an 18 month period (age 12–82 years; mean 55.1 years). 64 patients (69.6%) had evidence of metastatic disease within the spinal canal (extradural $n=45$, intradural $n=12$, intramedullary $n=7$). Extradural deposits resulting in compression of the spinal cord or cauda equina were diagnosed in 39/45 patients (86.7%). The thoracic spine was the most frequent site of cord compression (30/39, 77%). Compression at more than one spinal level occurred in 12/39 patients (30.8%). A clinical assessment of the likely level of cord compression was made in 18/39 cases, but was accurate in only eight patients (44.4%). The most common primary tumour sites were prostate ($n=12$) and breast ($n=9$). Intradural metastases were multiple in 10/12 patients. Four of the six solitary intramedullary metastases were situated in the conus medullaris. Lumbar disc herniation was present in three patients, but none had evidence of coincidental malignant infiltration. CONCLUSION: In malignant disease almost one-third of patients (30.8%) demonstrate cord compression at multiple levels and a similar number (29.7%) have symptoms resulting from intradural or intramedullary deposits.

1250
Analysis of intravertebral axial rotation in adolescent idiopathic scoliosis using 3D MRI
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PURPOSE: To define the proportion of segmental axial rotation that occurs due to intravertebral deformity in patients with adolescent idiopathic scoliosis using 3D MRI. METHODS: Patients with adolescent idiopathic scoliosis were imaged with a Siemens IT impact scanner using dual echo steady state gradient echo T_2 weighting (TR 30 ms/TE 9/45 ms/40°). 3D volume images of the apical 10 vertebrae were obtained in the axial plane and post-processed through multiplanar reconstruction. Using a novel and reproducible technique, previously established by the authors, sections through the superior and inferior end-plates were selected, allowing axial reconstructions to be obtained in the plane of each end-plate. Axial rotation was measured by comparing the angle subtended by datum points along the inner surfaces of the laminae, with a vertical drawn by the computer. An absolute measurement was determined by reference to a neurally-rotated vertebra (T1 or L5, previously identified from plain films) that had been included in the image acquisition. Measurement of rotation at individual end-plates thereby allowed the proportion of intravertebral and intervertebral deformity within each scoliotic curve to be determined. RESULTS: 10 patients (eight girls and two boys, aged 12–19 years) with adolescent idiopathic scoliosis were included in the study. Each patient had a right thoracic curve, with a mean Cobb angle of 49° (range 30° 61°). The mean change in axial rotation observed in progressing from end vertebra to apical vertebra was 28°, range 20°–34°. The mean proportion of axial rotation within the overall scoliotic curve occurring on an intravertebral basis was 34%, with a range of 9%–76%. CONCLUSIONS: A significant, but variable, amount of the overall scoliotic deformity in patients with adolescent idiopathic scoliosis occurs as a result of intravertebral rotation, an observation that has not previously been established. In half of the patients imaged in this study, intravertebral deformity contributed to over 45% of the total scoliotic axial rotation. These findings suggest that derotational spinal surgery is likely to produce suboptimal results in those patients in whom a particularly large degree of intravertebral rotation exists. This study implies that assessment of end-plate rotation with 3D MRI is a useful means of identifying a subgroup of patients in whom derotational surgery is likely to be of limited benefit.

1215–1245
Keynote Lecture
CT of the Pancreas
Hall 11b

1215
Invited Review
The role of CT scanning of the pancreas
S A Scott
CT Scanner Department, Gwynedd Hospital, Bangor, LL57 2PW, UK
CT of the pancreas is a well-established imaging technique. The accuracy of CT has increased, due to improved techniques, especially since the advent of spiral/helical CT. This paper intends to establish the past, present and future use of CT in imaging malignant and non-malignant disease of the pancreas, whilst quantifying the role of other modalities as relevant. Particular emphasis will be given to the imaging techniques currently used to scan the pancreas, as well as the use of CT in interventional procedures involving the pancreas, to establish a pathology. The paper will also consider patient care and the radiation burden of CT scanning of this organ.

1300–1345
Institute of Physics & Engineering in Medicine
Douglas Lea Lecture
Hall 1

1300
Eponymous Lecture
The effects of small doses of ionizing radiation on human health
R Doll
Cancer Studies Unit, Radcliffe Infirmary, Oxford OX2 6HE, UK
The subject discussed has been a controversial issue ever since the explosion of the first hydrogen bomb in the Pacific in 1954, when radioactive nuclides were distributed throughout the world. Large effects have been claimed, as among the residents of Seascale near Sellafield, small effects have been denied, as from exposure of the fetus *in utero*, and small doses have been claimed to be beneficial. The evidence for harmful effects from small doses (less than 20 mGy) on the developing brain and on the risks of hereditary disease, cancer (including lung cancer from radon in houses) and possibly other conditions will be discussed and, as far as possible, quantified and the evidence for hormesis examined.

MONDAY

1355–1515
Scientific Session
Fluoroscopy Dose Reduction
Hall 9

1355
Invited Review
Fluoroscopy dose reduction
S Field
Department of Diagnostic Radiology, Kent and Canterbury Hospital, Canterbury CT1 3NG, UK
The doses received by patients from diagnostic medical X-rays comprise about 87% of the total collective dose to the population of the UK from all man-made sources of radiation. Fluoroscopic examinations, both the more traditional barium studies and arteriography, as well as the more recent interventional examinations, can produce significant and, indeed, some of the largest doses that patients are likely to receive during a visit to the radiology department. The ways in which radiation dose to the patient can be reduced will be discussed.

1425
Development of reference dose levels in interventional radiology
K Faulkner, N W Marshall, A R Lecomber and C J Kotre
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In recent years there has been a dramatic expansion in both the number and nature of interventional radiology procedures. The contribution of interventional radiology procedures to the collective effective dose of the UK is both increasing and unknown in magnitude; radiation exposures in interventional radiology are determined using reference dose levels. There are two fundamentally and philosophically different approaches to the development of reference doses in this context. One involves measurement of dose/image and dose rates using a patient equivalent phantom. The other involves dosimetry on a series of patients having one particular type of procedure. Each of these approaches has its own advantages and protagonists. This presentation will review the issues underlying the establishment of reference dose-levels in interventional radiology. Initial results of a European survey into dose levels will be presented and discussed.

1435
Knowledge of patient radiation exposure amongst medical staff
[1]A O'Connor, [2]J M Wide, [2]G Abbott and [1]E O'Grady
Departments of Radiology, [1]Aintree Hospitals, Liverpool, L9 7AL and [2]Countess of Chester Hospital, Chester CH2 1UL, UK
The Ionizing Radiation (POPUMET) Regulations 1988 require all concerned, including clinicians, to reduce unnecessary exposure of patients to radiation. This may be achieved by judicious use of investigations involving ionizing radiation and using alternative techniques when, and if, appropriate. The Royal College of Radiologists has issued guidelines on the appropriate use of radiological investigations and clinicians should have attended a course on the "Core of Knowledge" of the Ionising Radiation Regulations. Reducing the amount of radiation administered through radiological medical examinations depends, to a significant degree, on the referring clinicians and their perception of what constitute high and low dose ionizing procedures. We assessed the knowledge of relative radiation doses by referring clinicians. Questionnaires were sent to all senior and junior medical staff at two hospitals, one a teaching hospital and the other a large district hospital. Clinicians were asked to state their awareness and use of the guidelines issued by the Royal College of Radiologists and whether they had attended a course on ionizing radiation regulations. They were then asked to complete a table giving a relative estimate of radiation dose for 20 different, commonly performed, radiological procedures (including plain films, bariums, CT, MRI, nuclear medicine and US) compared with that of a single PA chest radiograph, equivalent to about 3 days natural background radiation. The majority of clinicians significantly under-estimated the radiation dose of commonly-performed examinations; some perceived non-ionizing techniques as using ionizing radiation. The results of the survey are presented and discussed.

1445
Protection of the unknown pregnancy—advice on diagnostic ionizing procedures
C Sharp
Medical Department, NRPB, Chilton, Didcot OX11 0RQ, UK
In 1985, NRPB provided advice on the exposure of women, who are, or may be, pregnant to ionizing radiation. This advice suggested that there would be no risks to the conceptus following irradiation during the first 10 days of the menstrual cycle (as there will be no conceptus) and that subsequent risks in the remainder of the first 4 week period would be likely to be so small that no special limitation on exposure was required. Data published since 1985 suggest that risks in the interval between 10 days and the date at which the next period is due, whilst still small for most diagnostic procedures, may be significant for higher dose procedures. Consequently, it is considered that there is a need to operate a modified policy for these procedures. This paper will discuss the principles and implementation of this practical advice, supported by relevant scientific data. A concise and user-friendly pocket book, providing a practical guide for the implementation of the recent NRPB advice on this issue in everyday practice, is to be published during Radiology 1998 and will be available free of charge at the Congress.

1455
Dose reduction in CT scanning by the use of male gonad shielding
R Price, P Halson and M A Sampson
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CT scanning has been shown to involve substantial irradiation of local tissues. We have investigated the radiation dose to the male gonads during 20 standard pelvis scans where the testes were not the target organ, *i.e.* they form the innocent bystander. Doses were in the range 1–>10 mGy and were comparable with the doses measured on a tissue-equivalent phantom during a test series of 20 examinations measuring dose directly and indirectly at four separate positions, to assess the contribution of scatter. The purpose of this study was to demonstrate and measure the reduction in the diagnostically-unnecessary dose, received by male patients undergoing CT scanning, by the use of a purpose-designed lead gonad shield. This consists of a self-applied, wrap-around 1 mm lead-equivalent pouch, with disposable liner, which does not interfere with pelvic imaging. 80 readings have been obtained using the shield thus far. Shielding reduces the scattered radiation to the testes by approximately 50% and direct radiation by 90%. No increase in the measured dose at the anterior iliac spine, pubis or thigh caused by the use of the shielding device has been observed. The results are statistically significant ($p>0.0001$). CONCLUSION: The use of a simple lead shield reduces male gonad dose significantly, without increasing skin dose, and use of this type of device should become standard practice in modern imaging departments.

1505
Monte Carlo modelling in chest and lumbar spine radiography
[1]G H McVey, [2]M Sandborg, [1]D R Dance, [2]G Alm Carlsson and [2]J Persliden
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PURPOSE: A Monte Carlo code has been developed to realistically model the X-ray imaging system and patient. It is being used to study image quality and patient dose, and to optimize the design of the imaging system. A key feature is the use of the voxel phantom, developed by Zubal et al to simulate the patient. This paper establishes the validity and limitations of our approach by comparing calculations with patient measurements. METHOD: 58 chest and 42 lumbar spine radiographs were obtained in frontal or lateral projections under closely controlled and defined conditions. The entrance air kerma was measured for each film. The images were digitized and the dynamic ranges of the images were determined. The same quantities were calculated using the Monte Carlo program and the known exposure parameters. RESULTS: After small adjustments were made to the phantom, the calculations of entrance air kerma agreed well with the measured values, the maximum difference being 24% (chest PA). The dynamic range comparisons were more variable, with differences of 4% and 60% (lumbar spine PA and lateral) and 35% and 15% (chest PA and lateral). CONCLUSIONS: The adjusted voxel phantom can be considered representative of a patient for dose estimations, but should be used with some caution in situations for which the dynamic range of the image is a key influence on system design.

1400–1530
State of the Art Symposium
Imaging the Biliary Tree: The Current Role of Ultrasound, PTC, ERCP, MRCP and CTC
Hall 1

1400
Invited Review
The role of US and CT cholangiography in imaging of the biliary tree
P J Shorvon
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ULTRASOUND: Conventional transabdominal US imaging remains the primary modality for examination of the biliary tree. The technique has a very high accuracy for the detection of gallstones in the gall bladder and for the detection of complications of gallstone disease. Gallstones can be missed, particularly in contracted gall bladders, as well as occasionally in the fundus and neck of the gall bladder. Small stones and microlithiasis can also be overlooked. US can assess gall bladder emptying and benign disease, but is less accurate in the staging of malignant gall bladder disease. Biliary dilatation is regularly diagnosed, apart from in patients with intermittent benign obstruction and with fibrotic livers. US is insensitive in the detection of choledocholithiasis, but has a high specificity. Endoscopic US (EUS) is probably the most accurate technique in experienced hands for diagnosing common bile duct stones. CT CHOLANGIOGRAPHY (CTC): CTC requires iv cholangiographic contrast media, with high quality spiral CT. It produces an accurate depiction of the biliary tree, with the potential for both 3D and MIP reconstruction. Common duct stones are readily diagnosed. Compared with magnetic resonance cholangiopancreatography (MRCP) it has a number of disadvantages—radiation dose and inferior vena cava contrast media administration, and requires functioning hepatocytes. It gives no information about the pancreatic duct. It can be used in similar biliary indications as MRCP, but is generally only used if MRCP is not available, or if the patient has a contraindication to MRI.

1415
Invited Review
Magnetic resonance cholangiopancreatography
D J Lomas
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Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive imaging technique that allows demonstration of the biliary and main pancreatic duct systems. The technique has been widely taken up and evaluation of its clinical role is continuing. This presentation will cover current MRCP techniques, specific advantages over other techniques, disadvantages and limitations. It also provides illustrations of its current use in hepatobiliary disease.

1435
Invited Review
Direct cholangiography and pancreatography in the 1990s
M B Sheridan
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In the past 5 years there have been great advances in non-invasive imaging of the biliary tree and pancreas, particularly with the advent of spiral CT, contrast-enhanced MRI and improvements in resolution of transabdominal ultrasonography. In addition, MRI can produce both cholangiograms and pancreatograms, and CT can now produce cholangiographic images. This has resulted in a change of emphasis away from the invasive examinations of endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC). The overwhelming advantage of these procedures is the ability to change a diagnostic examination into a therapeutic procedure. This therapeutic role is well-established, but the place of diagnostic ERCP and PTC is looking more tenuous each day. The role of these examinations as part of the diagnostic armamentarium and their place alongside newer, non-invasive techniques will be discussed.

1500
Discussion

1400–1510
Scientific Session
Clinical Practice in Oncology
Hall 10a

1400
Assessment of bulk in mediastinal Hodgkin's disease: a comparative study of plain radiography and CT
[1]A J Bradley, [1]B M Carrington, [1]J A L Lawrance, [2]W D G Ryder and [3]J A Radford
Departments of [1]Diagnostic Radiology, [2]Medical Statistics and [3]Medical Oncology, The Christie Hospital, Wilmslow Road, Manchester M20 4BX, UK
Mediastinal bulk disease is defined as when the ratio of the maximum transverse mass diameter over the internal thoracic diameter at T5/6 level is >0.33 on a chest radiograph (CXR). This study evaluates how CT measurements of bulk correspond to those from the CXR. 95 adult patients with Hodgkin's disease (HD), treated at the Christie Hosptial 1989–1996, with bulk or near-bulk mediastinal disease on the CXR (thoracic ratio of >0.3) and a CT scan within 28 days of the CXR were included, provided that both investigations were performed prior to treatment. Measurements of the widest mediastinal diameter including the mass (WMD) and internal thoracic diameter at the T5/6 intervertebral disc space (ITD) were made on both CXR and CT scans. The thoracic ratio (TR) for each modality was calculated. For each patient, the paired measurements were analysed using the Student's t test. The longest diameter of the largest individual nodal mass (LIM) was also measured from the CT. Due to the effect of magnification, WMD_{CT} and ITD_{CT} were almost invariably smaller than WMD_{CXR} and ITD_{CXR} respectively ($p<0.0001$). This effect was more obvious with larger measurements ($p<0.0003$). There was excellent correlation between CT and CXR for measurement of TR. TR_{CT} were slightly larger than TR_{CXR} with a mean difference of 2% ($p<0.0001$), which was not related to the value of TR ($p<0.65$). A ratio of 0.33 (CXR) was found to be equivalent to a ratio of 0.35 (CT). The mean difference between LIM_{CT} and WMD_{CT} was 1.83 cm [LIM_{CT} smaller than WMD_{CT} ($p<0.0001$)]. No single measurement of nodal size correlated to the current definition of bulk. LIM_{CT} is being compared with freedom from progression and these results will be discussed.

1410
Relation of lectin binding to invasiveness and lymph node metases in oral cancers
[1]T Vijayakumar, [2]V N Bhattathiri, [2]P Remani, [2]L Bindu, [3]B Chandralekha and [2]M K Nair
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Squamous cell carcinomas of the oral cavity are one of the commonest cancers seen in Kerala. The size of the primary tumour, invasion of adjacent structures and lymph node metastases are important factors that influence prognosis. The cell membrane is known to play a role in the metastatic process. In this study an attempt was made to evaluate the relationship between the lectin binding pattern of oral cancer cells in cytological smears and their capacity to invade locally and metastasize to the lymph node. Smears were collected from 70 (40 males and 30 females) untreated patients with histopathologically-proven squamous cell carcinoma of the oral cavity. The cells were stained with jackfruit lectin (JFL), conjugated to horse radish peroxidase (HRP) using diamino benzidine dihydrochloride (DAB) as the substrate. The frequency of cells showing lectin binding and the intensity of binding were evaluated. The results showed that tumours having a high frequency of lectin binding cells had high risk of lymph node metastasis, whereas the reverse was true for local invasiveness. It was also observed that a combined score, integrating known clinical parameters, such as primary tumour size, local invasion and histological sub-group with percentage of lectin binding, was more useful than any of these when individually assessed to predict the risk of invasiveness and lymph node metastasis. The density of sugar residues on the cell surface may be playing an important role in determining lymph node metastasis and the invasiveness potential of oral cancers. This study shows that lectin binding characteristics might be helpful in identifying the invasiveness of tumour cells.

1420

Dose evaluation of 3D conformal radiotherapy of nasopharyngeal carcinoma

V Wu, J Sham and R Li

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Since the early 1960s, external beam radiotherapy techniques, which are based on a 2D approach, have been the main treatment modality for nasopharyngeal carcinoma (NPC) a common malignancy in Hong Kong. These techniques use coplanar treatment fields with generous margins, which inevitably include adjacent normal structures; radiation-induced late complications are not uncommon. With the advancement of computer technologies and therapy machines, 3D conformal radiotherapy (3DCRT) is now available. This study used 3DCRT to treat NPC and analysed the dose distribution of the target volume and normal structures. Four 3DCRT techniques, including three five-field and one seven-field techniques, were designed on 16 selected patients using an advanced 3D radiotherapy computer-planning system. Dose distributions were compared with three current 2D techniques by means of plan evaluation facilities, such as dose–volume histogram and 3D dose display. Besides the target volume, nine adjacent normal structures were selected for dose investigation, in which the maximum, minimum, mean and 80% volume doses were studied. A special ranking system, which was based on total point scores achieved by individual techniques, was designed to facilitate comparison among the techniques. Results showed that, for early and moderate stages of NPC, 3DCRT techniques were superior to 2D techniques, in terms of reducing the doses to the normal structures, with little difference in the target volume dose. However, this advantage was lost for large extensive primary tumours.

1430

Is it necessary to treat posterior cervical lymph nodes in the radiotherapy of oral cancer?

M Niewald, K Lederer, M Rudi, N Licht, K Walter, U Nestle, H Iro, H Landau and K Schnabel

Department of Radiotherapy, University Hospital of Saarland, Homburg D-66421, Germany

PURPOSE: We examined retrospectively whether the inclusion of posterior cervical lymph nodes (PCLN) in the target volume influences prognosis in the radiotherapy of oral cancer. PATIENTS AND METHODS: The data of 151 patients with oral cancer who had been operated on were evaluated. In 64 patients, the PCLN had been included in the target volume; in the remaining 87 they were not. All patients were treated with irregularly-shaped lateral opposing portals using ^{60}Co γ-rays or 4–6 MV photons from a linear accelerator. The majority of patients received a total dose in the range 60–82.8 Gy (single dose 1.2 Gy twice a day, or 2.0 Gy once a day), PCLN having received a total dose of 30–60 Gy. Mean follow-up was 3.6 years. RESULTS: There was a statistical bias in favour of patients whose PCLN had not been irradiated. A tumour growth posterior to the vertebral body was never observed. Locoregional tumour outcome, survival and progression-free survival were identical in both groups. Using COX regression hazard model, the dose to the PCLN was never an independent prognostic factor. CONCLUSION: Our data suggest that the inclusion of PCLN in the target volume in radiotherapy of oral cancer is not advisable unless there is proven tumour involvement in this region.

1440

Concurrent platinum and docetaxel chemotherapy combined with external irradiation for patients with transitional cell bladder carcinoma

H Varveris, E Orfanoudaki, D Haldeopoulos, M Mazonakis, D Delakas, P Anezinis, G Metaxaris, S Karabekios, J Damilakis, N Chondros, E Mavromanolakis, G Daskalopoulos and A Kranidis

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PURPOSE: The study evaluated the toxicity and efficacy of concurrent chemotherapy with cisplatinum and docetaxel, and external radiotherapy for transitional cell carcinoma of the urinary bladder. MATERIAL AND METHODS: 42 patients (34 male, 8 females) with invasive bladder carcinoma (clinical stages T1–4) were treated after transurethral biopsy with chemotherapy and concomitant external radiotherapy. Chemotherapy, consisting of cisplatin infusion (30 mg m^{-2}) and Docetaxel (40 mg ml^{-2}) was given twice a week simultaneously with irradiation during the whole treatment period (6–8 weeks). An external irradiation scheme (1.8–2.0 Gy per fraction, 5 days a week) was used up to 68–74 Gy (6 MeV photons) total tumour dose. RESULTS: All but five patients completed the planned chemoradiation protocol. The complete response rate assessed at 3 months after completion of combined treatment was 100%, 63.6%, 46.15% and 95% for clinical stage (c) cT1 (9/9), cT2 (7/11), cT3 (6/13) and cT4 (1/4) cases, respectively. None of nine patients with T1 tumours had any local failure at 36.1 months mean follow-up time. Nine of 37 patients (24.32%) relapsed locally and/or distantly and were followed for 25.04 months (mean time). 32 cases remain alive 19–46 months after treatment; 27 of those have no evidence of disease with a mean follow-up time of 32.24 months. Chemotherapy was discontinued in two cases due to acute gastrointestinal toxicity and in three more due to patient compliance. There was one toxicity death, 2 months after treatment completion, due to ureteral obstruction and impaired renal function. The acute toxicity was estimated as moderate to severe and caused the interruption of treatment for 5–10 days in eight of 37 patients (21.62%). Myelotoxicity appeared in 22/37 patients but febrile Grade III and IV neutropenia was observed in three patients (8.10%) and thrombocytopenia (Grade I–III) in 8 (21.62%). Concerning late effects: a sigmoid stricture, a transient small bowel obstruction, four patients with contracted bladder and one case of renal failure were shown. Grade I–III hypersensitivity reactions appeared in 8/37 patients (21.62%) while stomatitis (Grade I–II) and Grade II skin toxicity appeared in three and four patients respectively. These and other symptoms (Grade I–II peripheral edema, transient myalgias and arthralgias in 7/37 cases), paresthesias or numbness (3/37) and peripheral motor dysfunction (1/37) were responsible for early reduction of docetaxel dose from 40 mg m^{-2} to 20 mg m^{-2}. CONCLUSION: This preliminary analysis suggest that the radiosensitizing effect of cisplatin and docetaxel to megavoltage irradiation yielded a high CR rate in transitional cell bladder carcinoma patients with medium to severe early and late side effects. The value of such a combined treatment, as far as the tumour eradication is concerned, requires further evaluation because of the small number of patients, the short follow-up, and the absence of other studies using docetaxel as a radiosensitizer in urothelial cell cancer.

1450

Old almost as good as new

R L Harris

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On-set portal imaging is widely accepted as an important tool for daily and weekly verification of field and patient position and is imperative for improved quality assurance and accuracy. In recent years there has been much emphasis on the introduction of electronic on-line imaging. Such systems have proved invaluable. They have increased the significance of image verification in detecting discrepancies and aided the advancement of other innovative practices, such as conformal therapy. It is important to remember that, whilst this technology is progressing, a large proportion of centres, both nationally and internationally, do not have such facilities. In a recent survey of 37 UK departments, nine had on-line imaging facilities, but 28 did not. Many centres still have to rely on the use of conventional film and cassette for imaging. Clearly, there is room for improvement, but such centres can still actively participate in routine verification. The survey revealed that a wide variety of film and cassette types were being used; many not specifically designed for therapy verification. Exposures also varied, for example, from machine settings of four, to 50 monitor units for single exposures to the chest at comparable energies. The aim of this paper is to share Plymouth's experiences in vastly improving our previously poor conventional image quality, whilst reducing the monitor units required. Although our department now has electronic on-line imaging facilities, routine verification was previously achievable via the improvement of conventional methods.

1500

The experience of radiation-induced diarrhoea in women undergoing pelvic radiotherapy for gynaecological cancer

G Francis

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PURPOSE: To reveal the effects of diarrhoea from the patients' perspective, within the context of their daily lives, previously unexplored by studied employing purely quantitative methods. METHODS: Quantitative and qualitative data was collected over a 2 month period by diary-interview. Data were analysed to determine the magnitude, relative importance and impact of this phenomenon and to identify the coping strategies adopted. RESULTS: An 83% incidence of diarrhoea ($n=12$) was revealed. Low fibre diets were adopted by the participants and many also avoided fatty foods as both high fibre and fatty foods exacerbated symptoms. Codeine phosphate and imodium were prescribed, although their use was avoided due to their

constipating effect. Lack of predictability of diarrhoea, urgency and fear of constipation made the disturbances particularly difficult to deal with. Severity of symptoms did not necessarily indicate magnitude of distress. Gastrointestinal disturbances (in combination with fatigue) had a negative impact on travelling, recreation and sense of well-being. Coping strategies included downward comparison, efforts to maintain usual life pattern and establishing a sense of control. CONCLUSIONS: Diarrhoea will be under-reported if information is not sensitivity elicited. Understanding coping strategies will help radiographers to sensitively respond to the needs of patients in their care. The hiatus in care after the end of treatment, at a time when coping strategies are particularly stretched, could be alleviated in part by telephone help-lines until first follow-up. The optimum diet and the extent of chronic bowel disturbance due to external beam irradiation, requires further study.

1400–1540
State of the Art Symposium
New Dosimetry Protocols Implementation
Hall 10b

1400
Invited Review
Overview of the kV X-ray and electron dosimetry protocols
R M Harrison
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Outlines of two new dosimetry Codes of Practice are given. The Code for the determination of absorbed dose for X-rays below 300 kV has introduced several changes. (i) Dose determination is based on the air kerma determination (exposure measurement) method. (ii) An air kerma calibration factor for the ionization chamber is used. (iii) The F (rad/Röntgen) conversion factor is replaced by the mass–energy absorption coefficient ratio of water and air for converting absorbed dose to air to absorbed dose to water. (iv) Perturbation factors are incorporated: (v) New back-scatter factors are recommended. (vi) Three separate energy rates are defined, with specific procedures for each range (medium energy: 0.5–4 mm Cu HVL, low energy: 1.0–8.0 Al HVL and very low energy: 0.035–1.0 mm Al HVL). The Code for electron dosimetry for radiotherapy beams of initial energy 2–50 MeV is based on the 2 MV (or ^{60}Co) air kerma calibration of the NE 2561/2611 chamber (used as a transfer instrument between a national standards laboratory and UK hospitals) and utilizes an $N_{D,air}$ approach. NE2571 designated chambers are calibrated against the transfer instrument in a megavoltage photon beam and three parallel plate designated chambers are calibrated against the NE2571 in a higher energy electron beam.

1425
Invited Review
Low kV protocols
G Pitchford
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This presentation discusses the implementation of the Institute of Physics & Engineering in Medicine (IPEM) code of practice for the determination of absorbed dose for X-rays <300 kV generating potential. The code gives absorbed dose determination procedures for three distinct energy ranges. This presentation will only consider the low-energy and the very low-energy X-ray sections, covering radiation qualities from 0.035 mm Al to 8.0 mm Al half-value layer (HVL). A comparison with the previous (Hospital Physics Association (HPA) code of practice will be made. Calibration results based on absorbed dose determinations using the old and new protocols will be presented.

1450
Invited Review
Practical experience of implementing the IPEM electron protocol
T J Jordan and S E Vollans
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The Institute of Physics and Engineering in Medicine (IPEM) air-kerma based protocol for electron dosimetry (1996) is a significant step forward in bringing electron dosimetry in the UK to state-of-the-art and comparable with best international practice. By necessity, it contains recommendations and advice on assessing the magnitude of correction factors required for use with ionization chambers in electron beams and the difficult problem of relating electron beam dosimetry back to primary standards for photon beams. This, however, makes the code quite detailed and requires a significant amount of work to implement properly. It is essential to follow the recommendations provided in the code of practice, but a check on the accuracy may be obtained with a simpler approach, which either ignores or estimates some of the corrections. The errors involved in this approach for both the Markus and the NACP electron chambers are quantified. It is difficult to assess the change in dose specification associated with the new code, relative to the 1985 code (and 1992 supplement), as the opportunity has been taken to simultaneously implement a number of changes in practice (*e.g.* measurements based on water, rather than solid phantoms, and a change in our reference electron chamber). However, the overall changes to the dosimetry specification at the Christie hospital will be given and might be expected to be typical of that which may be found by other centres. The proposed introduction by the National Physical Laboratory of an absorbed dose to water service for electrons based on a graphite calorimeter and using different energies of electron beams, permits an independent comparison with the results of this study. Significant differences were found between the two approaches for both the NACP and Markus chambers and these results will be presented.

1515
Practical implementation of the new IPEM very low energy dosimetry protocol
A G Greener, P J Rudd and J E Saunders
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The new Institute of Physics & Engineering in Medicine (IPEM) dosimetry protocol for very low energy X-rays has been implemented for a 30 kVp, 0.22 mm Al HVL beam, running on a recently commissioned Darpac 2000 superficial X-ray unit. Practical problems encountered in intoducing this new code included the use of full scatter phantoms, as well as additional build-up material required to bring the build-up on the thin window chambers to the required thickness of 8.5 mg cm^{-2}. Dosimetric problems were encountered when trying to reconcile this code with both the previous code and the new low energy code (1–8 mm Al HVL). Comparison of the very low and low energy codes at the "cross over" beam quality of 1 mm Al HVL (55 kVp) on this unit produced calculated dose rates that differed by up to 6%, the very low energy code producing the lower calculated dose rate. This difference would seem to give an indication of the value of the correction factor Kch at this quality, whose largest component is likely to be due to scatter from the chamber housing material into the sensitive volume. Due to insufficient data, Kch was assigned a value of unity in the new code. A value of Kch = 1.03 has been assigned locally to our beam to account for scatter from the chamber housing and a 1.5% correction is made to correct for the attenuation of the beam caused by the required additional build-up material. These corrections ensure consistency in delivered dose between the new and previously-used treatment units.

1525
Discussion

1400–1530
State of the Art Symposium
Nuclear Medicine—Pulmonary Embolism
Hall 11b

1400
Invited Review
Perfusion imaging in pulmonary embolism
M Buxton-Thomas
Department of Nuclear Medicine, King's College Hospital, Denmark Hill, London SE5 9RS, UK
Many investigations are now performed in the diagnosis of pulmonary embolism (PE). Pulmonary angiography has been the "gold standard" for this diagnosis, although helical CT may become acceptable in due course. Both procedures involve opacification of

the pulmonary vessels with contrast medium. Pulmonary embolism is the passage of foreign material (clot, air, fat or albumin particles) into one of the branches of the pulmonary artery, causing local obstruction of blood flow. While morphological procedures have the advantage of demonstrating the occluding material, functional imaging using radionuclides demonstrates physiology and allows quantitation. Blood flow (like ventilation) throughout the lung is non-uniform due to the effect of gravity which induces hydrostatic effects in the pulmonary circulation because it is a low pressure system, so pulmonary blood flow is greater in the dependent regions. Performing scintigraphy gives a relatively non-invasive method of demonstrating pulmonary perfusion in the diagnosis of PE. Using $^{99}Tc^{m}$ MAA (less often, microspheres) a slow intravenous injection in the recumbent position (to minimize the effect of gravity) will demonstrate the occluded segment(s) of lung in a patient with PE. Examples of perfusion scans in the differential diagnosis of PE will be given and algorithms for the follow-up of patients before and after treatment (especially thombolysis) wil be discussed.

1425
Invited Review
Ventilation imaging in pulmonary embolism
M J O'Doherty
Department of Nuclear Medicine, Guy's and St Thomas' Hospital, London SE1 7EH and Kent and Canterbury Hospital, Canterbury CT1 3NG, UK
Pulmonary embolism and its diagnosis is most conveniently examined using radionuclide imaging methods. It is necessary to perform both ventilation and perfusion scans within 24 h of the patient presenting with symptoms, since there is sufficient evidence to believe that some emboli will resolve within 24–48 h. The majority of the literature on reporting criteria for the diagnosis of pulmonary embolism from ventilation–perfusion studies (V/Q) has been based on ^{133}Xe as the ventilation agent. The optimum ventilation agent is almost certainly $^{81}Kr^{m}$ but its availability is limited to less than 1 week. Most departments in the UK use an aerosol system, either as the method of choice for ventilation imaging or as a back-up for $^{81}Kr^{m}$. There are a large number of systems available for aerosol generation, including jet or ultrasonic devices, "smoke" generators (APE or Technegas). There are safety measures necessary with aerosol devices, including adequate shielding of the nebuliser and a mechanism to ensure environmental contamination is reduced to a minimum. Re-use of medical devices is currently a subject of discussion and the risk for reusing single use devices essentially falls to the user or the user's Trust. The advantage of an aerosol system for ventilation imaging is that the radiopharmaceutical is available 7 days a week, as is the delivery device. This enables a V/Q service to be performed daily, as is the case with ^{133}Xe but often not with $^{81}Kr^{m}$. The addition of ventilation imaging allows the specificity of the test to increase, although a recent study (PISAPED) has returned to the age-old argument that the use of a chest radiograph is sufficient for comparison with a perfusion study. The advantages of $^{81}Kr^{m}$, are the ease with which comparable images to the perfusion study can be obtained and the ability to perform this after perfusion has been seen. ^{133}Xe gives a higher radiation dose to the patient and only allows limited views to be obtained, but does allow an every-day service. Aerosol devices are slightly more difficult to use than $^{81}Kr^{m}$, especially in young children, but usually provide diagnostic scans and can also give clues about other pathology in the lung.

1450
Invited Review
Reporting ventilation–perfusion scans
H W Gray
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The reporting of ventilation–perfusion (VQ) scans involves three main processes which are essential for full accuracy and cost-effectiveness. "Reproducible interpretation" of the VQ scan and chest radiograph is commended. Bayes theorem provides the principles for accuracy, clinical effectiveness and permits the "provision of a post-test diagnosis". The third aim is the provision of a "post-test diagnostic strategy" for the considerable number of studies where clinical doubt persists. This strategy will vary from institution to institution, but the principles are common to all. Greater use of leg tests and CT angiography are envisaged.

1515
Discussion

1400–1520
Scientific Session
Breast Diseases
Olympian Suite

1400
Invited Review
Expanding professional practice in mammography
P L Williams
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This paper considers the current and future role of radiographers working in breast screening, in the context of the general changes in working practices in the NHS. It is acknowledged that such radiographers are highly specialized and qualified personnel. Although regular updating has been a requirement of the training programme, once qualified there is currently little opportunity for them to develop further in their chosen clinical field. However, recent changes in the organization of health services have provided the impetus for significant transformation in working practices. The boundaries which have traditionally marked the division between professional groups are breaking down in response to a range of initiatives. Many professionals are now having to define their "core" skills, relinquish some aspects of their traditional role and take on new duties. These changes are in tune with the notion of life-long learning where, throughout their career, professionals are changing the scope and quality of their competence by becoming more specialist, moving into newly developing areas, or becoming experts in their chosen field. Therefore, it is timely to consider the scope of professional practice for radiographers, and how this can be organized and recognized. A model of practice is suggested which includes primary, specialist and advanced roles. Each of these roles is linked with continuing education and career development, within which there is an opportunity to expand the practice of radiographers working in mammography.

1430
An evaluation of digitized mammograms
[1]J M Murphy, [1]N J O'Hare, [2]D Wheat, [2]P A McCarthy, [1]A Dowling, [1]R Hayes, [1]H Bowmer, [1]G F Wilson and [1]M P Molloy
[1]Department of Diagnostic Imaging and Medical Physics, St James Hospital, Dublin and [2]University College Hospital, Galway, Ireland
PURPOSE: The potenital advantages of displaying mammograms in a digital form include contrast manipulation and computerized enhancement of the images, telemammography, computer-assisted diagnosis and digital archiving. This study examined digitized mammograms both clinically and technically. METHOD: 30 mammograms were digitized at 4 K × 4 K spatial resolution and 12 bits pixel depth using a film digitizer. The mammograms contained 17 carcinomas in 16 patients. The mean size of the lesions was 2.8 cm and six lesions contained microcalcifications. Five consultant radiologists reported both the original mammograms and the digitized images. Various parameters, including resolution, signal-to-noise ratio, pixel depth, distortion and low contrast detectibility were evaluated. RESULTS: There was a correlation between the reports of the mammograms and the digitized images in relation to whether a suspicious lesion was present or not in 94.7% of cases. Microcalcification was reported less often on viewing the digitized images. There was no significant difference in the biopsy referral rate. There were no false positives on reporting the digitized images. The technical evaluation showed the system performed well within specifications. CONCLUSIONS: Film digitizers allow a good digital image of a mammogram to be obtained which allows potential image enhancement and transfer.

1440
How do radiologists interpret mammographic images?
M D Mugglestone and A G Gale
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The interpretation of mammographic images within a breast cancer screening environment is a difficult task due to the large number of cases that are studied and the low proportion of these which contain any abnormality. Understanding the processes that are involved in image intepretation is essential if diagnostic errors are to be minimized. This study examines the visual search behaviour of radiologists interpreting mammograms in their normal working environment. The visual search behaviour of six highly experienced

radiologists was monitored, using a head-mounted eye movement recording system. The system did not restrict the movement of the radiologists, who were also able to use a magnifying glass and interpret the images on multi-viewers in their normal way. The results show that each radiologist exhibited a unique search strategy, with no generic pattern evident. Data regarding how different mammographic views are utilized show that comparisons between different images are part of the diagnostic process, but are not utilized as much as may be expected. The results also highlight the speed with which cases can be examined and the importane of using a magnifying glass in image interpretation. The results give valuable insight into how radiologists interpret mammographic images in a realistic environment. The data provide a useful comparison for results that have been determined in laboratory-based experimental work. There are also implications for a number of different areas, especially regarding the introduction of new technoloqies, such a computer-aided diagnostic systems, and the potential for digital mammography and soft-copy image reporting.

1450

Radiological and pathological correlations of cancers detected preferentially with a second view at screening

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PURPOSE: The NHS Breast Screening Programme currently uses two view mammography for the prevalent (first) screening and single view mammography for incident (subsequent) screens. The United Kingdom Coordinating Committee on Cancer Research randomized controlled trial of two view mammography has shown a 24% increased cancer detection with two views. METHODS: We have studied a selected series of 158 incident screen cancers detected at the South West London Breast Screening Service 1994–1997. These were mixed with controls on test rollers and each roller was read by three experienced film readers. Initially, they read the obliques only, with previous screening round films, then re-read the rollers with the addition of the current cranio–caudal films. The readers noted any abnormal features seen and the degree of suspicion and likelihood of recall. Histological and radiological data were recorded for each case. RESULTS: Sensitivity for cancer detection increased overall with a second view of 6.8%. Detection of invasive cancers rose by 8.9% ($p<0.05$). Ductal carcinoma *in situ* detection fell by 2.1% (not significant) with the second view. This may be because it commonly manifests radiologically as calcifications. Invasive cancers preferentially visualized with a cranio–caudal view were most commonly small (< 15 mm diameter) and low grade (Grade I or II). The commonest helpful radiological feature was the presence of an irregular mass (distortion) on the second view not visualized on the oblique view. CONCLUSION: The addition of a cranio–caudal view at the incident round of screening preferentially aids detection of small invasive cancers, which are seen as irregular masses. These are prognostically of most significance for the screening programme.

1500

Database of mammography quality control phantom images and off-site evaluation system

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Departments of [1]Radiology and [2]Surgery, St Marianna University, Kawasaki; [3]National Institute of Radiological Sciences, Chiba; and [4]Kumamoto University, Kumamoto, Japan

PURPOSE: To develop an off-site objective evaluation system and database of mammography quality control (QC) phantom images. MATERIALS AND METHODS: 21 institutions participated in an image quality control survey and 47 images of American College of Radiology accreditation phantoms were submitted by mail for evaluation. They were digitized with a VXR-12 scanner, with a spatial resolution of 85 mm and contrast resolution of 8 or 12 bits/pixel. Signal-to-noise ratio (SNR) and contrast of phantom test objects were measured using NIH Image or IPLab Spectrum software. Results of these analyses and related technical data were entered into a database which was linked to files of digitized images. The analysis system and database was developed on a Macintosh computer. A QC report was prepared, based on the database. RESULTS: Digitization with 85 mm and 8-bit resolution could be used for analysis of the three largest groups of calcification specks and masses on the ACR phantoms. Analysis of images of five ACR phantoms revealed a significant variability between phantoms. Measures of test objects were normalized to correct the variability. A QC report containing evaluations and phantom images, together with measurements of test objects from high-quality images as references, was produced for each participating institution. CONCLUSION: This system is practical and provides objective evaluation of image quality for institutions. The QC data registered in the database can be used for statistical analyses of QC data obtained over a longer period of time.

1510

Is mammography of value in women with disseminated carcinoma of unknown origin?

K J Stevens, S L Smith, H Denley, S E Pinder and A J Evans

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INTRODUCTION: Mammography is often requested to try and identify an occult breast primary carcinoma in women with metastatic carcinoma of unknown primary site. This study aims to see if mammography was helpful in identifying the origin of the metastatic disease. METHODS: The notes and pathology records and mammography reports of 26 women presenting for mammography with disseminated carcinoma of unknown origin were reviewed. The presentation sites, pathological type of tumour, site of origin, benefit of mammography and mammography-provoked breast biopsy were clarified. RESULTS: The commonest presentation sites were lung, lymph nodes, nervous system, abdomen and bone. The site of origin was identified with confidence in 23 (88%). The commonest known primary tumour sites were lung (39%), breast (26%) and ovary (22%). Mammography was compatible with a breast primary carcinoma in four (15%). Three of these patients did not have breast cancer. In one the site of origin remained unknown. Six (23%) had a confident diagnosis of breast carcinoma. All these women had normal mammography. CONCLUSION: Mammography is of no value in identifying the primary site in women with disseminated carcinoma of unknown origin.

1500–1530
Keynote Lecture
Alternative Radiographic Techniques
Hall 11a

1500

Invited Review

Half-axial skull radiography—a new projection described

B K Denton

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Routine radiographic examination of the skull often includes the 30° fronto-occipital half-axial projection (or its reversed equivalent). This familiar projection, often referred to as Towne's, has enjoyed an unquestioned existence since the late 1920s. Critical evaluation reveals some most undesirable consequences, mainly in terms of radiation protection, but also in imaging sensibility and recording media utilization. The usual descriptions found in the popular textbooks generally utilize similar centring points which, by default, help to incur a large field size, often extending off the film, as well as image distortion and unneccessary irradiation of sensitive anatomical areas. Research into improving the principles and practices of plain radiography has resulted in a method of achieving a similar projection, whilst reducing radiation dose to vital areas. The new method also provides optimal use of the film and radiation beam. This is mainly possible due to the avoidance of using a centring "point" and, instead, using a field centring method which, as an added advantage, appears to remain useful for most age groups and size or shape of head. The resulting image demonstrates all clinically relevant information that is commonly required from the Townes projection, but is more straightforward to produce and may be done with improved consistency. In addition, it can be shown that radiation doses to the more radiosensitive areas, notably the lenses of the eyes and the thyroid gland, are vastly reduced, typically by factors of 85% and 100%, respectively. Furthermore, the radiation field size used is substantially reduced and utilized completely. This improved approach to an old, yet still prevalent, practice is particularly useful in trauma radiography when performed with conventional over-couch apparatus. The "Denton" half-axial projection of the skull carries valuable improvements over the traditional methods that still prevail and has so far been well received by both radiographers and radiologists. Due to the indicated dramatic savings in radiation dose alone, it should be further considered for use by all relevant imaging professionals.

MONDAY

1530–1700
Scientific Session
Vascular Imaging
Hall 9

1530

Does hyoscine butylbromide affect the incidence of silent ischaemia in patients undergoing angiographic procedures?

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PURPOSE: Hyoscine butylbromide (HB) is commonly used to halt gastrointestinal peristalsis and decrease motion artefact in digital subtraction angiography in the aorto–iliac region. One side effect is inhibition of vagal tone, leading to tachycardia, which can compromise myocardial blood supply and cause ischaemia. This study evaluates the effects of HB on the incidence of ischaemia during angiography. MATERIALS AND METHODS: A prospective randomized trial of patients undergoing angiography. To date, 29 patients have been excluded because of cardiac disease. The remaining 31 patients have been randomized into two groups, one receiving HB 20 mg iv during the angiogram, the other received no drug. Prior to the procedure, all patients were fitted with an ambulatory ECG monitor. At 24 h the tapes were analysed for ST depression by a technician blinded to the use of HB. RESULTS: Almost 50% of patients in each group had episodes of ST depression over the 24 h period. However, only two patients had significant ST depression during the angiogram itself, both were in the HB group. All episodes were asymptomatic. CONCLUSION: In this ongoing trial, episodes of silent ischaemia are not uncommon amongst patients undergoing angiography and may be increased by the use of HB. Further studies are necessary to quantify the risks in this group of patients.

1540

The role of rotational angiography in the assessment of native and transplant renal arteries

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PURPOSE: Visualization of renal arteries, especially at the origin, often requires multiple projections as the angle of take-off of the artery is variable. Rotational angiography allows multidirectional acquisition with a single injection and promises savings in time, contrast and radiation dose. We have evaluated this modality in both the native and transplant artery. METHOD: Prospective patient enrollment over a 7 month period; all studied using a GE Advantx LCA digital system. Rotational angiograms were considered diagnostic if no further imaging of the renal arteries was required. The arc of rotation, angle of renal artery take-off and the mean radiation dose were recorded. RESULTS: 98 native renal arteries and 12 transplant arteries were studied, of which 73 (65%) were diagnostic. In the remainder, rotational angiography accurately predicted the optimal angle for a diagnostic second static image. With native arteries, an arc of 120° was most useful. The mean angles for take off were R = 6° LAO and L = 0.5° LAO. In the transplant group, rotational arc of 150° was used and the angle of take-off was extremely variable (range of 105°). Radiation dose and volume of contrast used = 1248.4 cGy cm^{-2}, and 40–60 ml respectively per diagnostic procedure. CONCLUSION: Rotational angiography of renal arteries is a useful technique. For native arteries it can be diagnostic and accurately predicts the ideal angle for a diagnostic second acquisition; in the transplanted artery it is now a vital part of our diagnostic and interventional service. Contrast load is reduced and the radiation dose is not prohibitive.

1550

Mid-term results of endovascular repair of abdominal aortic aneurysms: sac length reduction and graft tortuosity

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SUMMARY: 33 patients were followed for up to 18 months after endovascular repair (EVR) for abdominal aortic aneurysm (AAA). Of 21 followed past 6 months, seven have kinked grafts. MATERIALS AND METHODS: Patients were investigated by CT and angiography to determine suitability for EVR. Follow-up was with CT at discharge, 1, 3, 6, 12 and 18 months, and with angiography at 12 months. RESULTS: 33 cases of AAA (27 male, six female, mean age 71, range 51–87) managed by EVR were technically successful, with primary exclusion of the sac at predischarge CT in 31 (93.9%). There were three deaths, one after conversion for graft disruption, one of graft infection at 12 months and one rupture due to continued primary proximal endoleak at 3 months. In 27 (81.8%) the aneurysm sac was excluded at mean follow-up of 8.03 months. 21 patients (15 male, six female) were followed past 6 months. There were two secondary distal limb endoleaks, two stump dislocations, managed by endovascular grafting, one requiring crossover graft for subsequent limb occlusion. Kinking of the graft in seven cases was associated with a mean reduction of the renal artery to aortic bifurcation distance of 13.3% (±8.4), compared with 10.4% (±10.8) for the group of 21 cases. No kinked graft developed occlusion, although one was associated with secondary endoleak. CONCLUSION: Primary exclusion of the sac was achieved in over 80% of cases at 8 months follow-up. Graft kinking may be associated with sac length reduction, but to date only one of these has been complicated.

1600

The role of angiography in the diagnosis of Meckel's diverticulum

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PURPOSE: To assess the sensitivity of angiography in determining the presence of a vitello–intestinal artery, or other arteriographic abnormality, in patients with a subsequently surgically-proven Meckel's diverticulum. MATERIALS AND METHODS: Histology of all patients who underwent a Meckel's diverticulectomy 1980–1997 were retrieved and all who had undergone preoperative angiography were selected for review. Those patients who had undergone angiography at this institution and had subsequently undergone a Meckel's diverticulectomy at the referring hospital were also included in this study. The case-notes and angiograms of these individuals were reviewed. RESULTS: The angiograms of 16 out of 18 patients were available for review. The ratio of male to female patients was 13:3. The mean age was 27.7 years (range 12–65 years and standard deviations = 15.8 years). In 11 of the 16 patients, a persistent vitello–intestinal artery was demonstrated (68.8%); this had been noted at the time of the study and reported prior to surgery in nine of the cases. Other angiographic abnormalities at the site of the Meckel's diverticulum were present in four patients and included a vascular blush, early venous return and arterial irregularity. In four individuals an angiographic abnormality, unrelated to the Meckel's diverticulum, was also demonstrated which was thought likely to account for the chronic gastrointestinal blood loss. CONCLUSION: Angiography is a sensitive technique for the diagnosis of a Meckel's diverticulum. A persistent vitello–intestinal artery will be demonstrable in the majority of individuals with this diagnosis who present with chronic gastrointestinal bleeding, although its recognition may require super-selective studies. The technique of this procedure will be discussed.

1610

A new method of simultaneous measurement of arterial and venous limb blood flow

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The major determinant of the severity of symptom in peripheral vascular disease is the blood flow to the affected region. This will depend on the degree of arterial narrowing and upon the number and size of the developed collateral vessels. Several methods have been proposed to measure limb blood flow, but none has been able to separate arterial inflow from venous outflow. A method for measuring limb blood flow during reactive hyperaemia has been developed. The method has the advantage that meaningful results are obtained without the need to measure limb volume or blood concentration. In addition, we are able to separate arterial inflow from venous outflow. Patients are positioned with their lower limbs within the field of view of a γ camera. $^{99}Tc^{m}$ HSA, which remains stable in the vascular space for a long time, is then injected into an antecubital vein and flushed with saline. A 3 min period is allowed for complete mixing of the tracer within the blood pool. A cuff inflation pressure of 50 mmHg above the patient's systolic pressure is then applied for 4 min to induce a hyperaemic response. The cuff is then released and a dynamic acquisition is acquired. The dynamic data is then processed by generating a time–activity curve (TAC) for each limb. The differentiation of the TAC results in a curve with

maximum and minimum points. The maximum point represents the maximum inflow (*i.e.* maximum arterial inflow) and the minimum represents the maximum outflow (*i.e.* the maximum venous outflow). A preliminary study of 20 patients suggests good correlation between this method and the previously described method (Parkin's method).

1620
Percutaneous coil embolization in the management of iatrogenic pseudoaneurysms
G J O'Sullivan, A M Belli and T M Buckenham
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PURPOSE: Ultrasound-guided compression repair (UGCR) is the first line therapy for iatrogenic pseudoaneurysms (IPA). If this fails, or is contraindicated, then other endovascular techniques, including embolization or endoluminal stent grafting, are available. We report our 6 year experience with embolization. METHODS AND MATERIALS: From 1991 to 1997 we have performed percutaneous coil embolization on a total of 24 patients. Of these, 17 were in the superficial (10) or common (seven) femoral arteries; two were in the superior/inferior gluteal artery and one each occurred in the superior mesenteric, radial, peroneal and subclavian arteries. Their mean age was 61 years; there were 16 males and eight females. RESULTS: Overall, we were successful in occluding the IPA in over 95% of cases. Although there are a number of potential complications associated with this procedure, superficial skin necrosis over a radial artery pseudoaneurysm in which the coils continued to unwind is the only one we have encountered. The average cost for the entire procedure, including follow-up, was £1 500 *vs* surgery at £2 300. CONCLUSION: If iatrogenic pseudoaneurysms require treatment, US-guided compression repair is the accepted first line therapy. Percutaneous embolization is reserved for those patients in whom this fails, or is contraindicated, but is a safe and highly efficacious technique.

1630
The use of the Angio-Seal haemostatic puncture closure device: initial UK experience
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PURPOSE: The increase in day case angiography and more complex interventional angiographic procedures has led to an increase in the incidence of access site complications. We report our initial experience of 50 patients with a self-sealing device which obviates the necessity to perform manual compression after arterial puncture. METHODS AND MATERIALS: The Angio-Seal haemostatic puncture closure device (Sherwood, Davis and Geck, Gosport, Hampshire, UK) is intended for use in closing the defect in the femoral arterial wall produced by percutaneous catheter access using 8 F or smaller sheaths or catheters. It consists of three completely bio-resorbable components. A detailed description of the device and its deployment will be provided. We have used this device in 50 arteries on 45 patients. All were considered at high risk of developing a haematoma for a variety of reasons. RESULTS: There was one major haematoma requiring operative removal. A further six patients developed small haematomas which settled on bed-rest. 17 out of 23 patients who were potentially well enough to mobilize early were mobilized after an average of 2.6 h. In six patients treated early in our experience we failed to deploy the device. CONCLUSION: Once the initial learning curve has been overcome, the Angio-Seal device is a simple and successful method of achieving arterial haemostasis following catheterization, it is associated with a low risk of complications.

1640
Carbon dioxide portography
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AIMS: To review our experience of carbon dioxide portography. METHOD: Nine patients with chronic liver disease, with a suspected diagnosis of portal vein thrombosis on at least one imaging modality, and a control population of 14 patients (either undergoing a TIPSS procedure, or orthotopic liver transplant work-up) underwent CO_2 portography, using a right femoral vein or right internal jugular vein approach. A 7 F balloon occlusion catheter was placed in a hepatic vein and the balloon inflated. 50 ml of medical grade carbon dioxide was injected by rapid hand injection, in suspended respiration, at 4 frame s^{-1}. RESULTS: Of the nine patients with suspected portal vein thrombosis: five patients were confirmed with portal vein thrombosis on CO_2 portography; four patients had patent portal veins. In the control group, the portal vein was well demonstrated in all cases. No significant complications were recorded. CONCLUSION: We have shown that carbon dioxide portography is a safe and effective method for assessing the portal vein, particularly in suspected portal vein thrombosis.

1650
A comparison of CO_2 and iodinated contrast arteriography
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PURPOSE: To evaluate the quality of CO_2 as an arterial contrast agent in peripheral and visceral arteriography using the Angiodynamics (USA) automated CO_2 delivery system and the IGE Advantx LCA (USA), with no additional modifications for CO_2 use. MATERIALS AND METHODS: Angiodynamics pigtail or other catheters, with Angiodynamics connectors, were used with the automated closed CO_2 delivery system. CO_2 injection volumes and rates up to 100 ml and 100 ml s^{-1} using digital subtraction at six images s^{-1}, with review of static and cine images, were compared with standard practice infradiaphragmatic arteriograms, using iodinated contrast medium. More than 50 arteriograms were performed. RESULTS: The Angiodynamics CO_2 delivery system was easy to use. 75% of studies performed were lower limb arteriograms and 50% were renal combined with a peripheral study, or a renal study alone. 75% of arteriograms were completed. 25% were stopped due to short-lived but intolerable patient symptoms, such as abdominal or leg pain. No serious complication occurred. 50% of studies were diagnostic overall, but this increased when separately analysing proximal lower limb and selective studies. The total radiation dose for arteriography with CO_2 was 5–50% greater than for iodinated contrast. CONCLUSION: The CO_2 delivery system is a safe and easily-used method for arteriography. For peripheral arteriography, the diagnostic benefit of CO_2 is limited in aortic flush studies and various technical and equipment factors are necessary to improve the diagnostic yield. A significant proportion of patients find CO_2 less tolerable than iodinated contrast medium, such that the CO_2 arteriogram could not be completed.

1530–1700
Controversy Corner
MRI for Radiographers— A Question of Field Strength
Olympian Suite

1530
Invited Review
Low field open MRI scanners
S Dunne
MRI Scanner, Bristol, Oncology Centre, Bristol BS2 8ED, UK
PURPOSE: To identify where low field open MRI excels and outline advantages and disadvantages of low field MRI scanners in comparison with closed high field systems. MATERIALS AND METHOD: To examine applications, patient friendliness, user friendliness, quality of images acquired and cost. Also types of hardware and software available and limitations of the technique and whether these present a problem in practice. RESULTS: Over 80% of principal radiological examinations (spine, head, pelvis, orthopaedics and cardiac) are achievable diagnostically on a low field system. Low field can be used for all standard sequences (spin echo, gradient echo, STIR, turbo sequences and 3D). Contrast may be better in T_1 weighted sequences. High quality images of limbs can be achieved by positioning regions of interest in the centre of the magnetic field. Software for dynamic joint studies, MR angiography and interventional work is available. Most patients who had been scanned on both types of scanner, preferred the open design and the quieter scans. Claustrophobic and paediatric patients can be scanned more successfully in an open scanner. SAR limits are seldom reached, even using fast multisliced T_2 weighted sequences. Low field systems require less capital to install and set-up. Limitations include longer scan times, restricted field of view and the fact that hard/software is still under development. CONCLUSION: Open low field systems have a wide range of useful applications and can be used successfully to give high quality images. The main advantages over closed systems are cost, patient

accessibility and visibility. Open low field systems are preferred by claustrophobic patients and paediatrics. However, fast or dynamic imaging is restricted, as are some specialist techniques.

1600
Invited Review
1.0–1.5 T closed field MRI scanners
S J Boddy
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PURPOSE: To outline the advantages and disadvantages of MRI scanning with a closed field system at 1.0–1.5 T. MATERIALS & METHODS: Scanner hardware and software, patient friendliness, quality of images, scan times, patient throughput and cost effectiveness will be looked at. The availability of research and future development potential will also be discussed. RESULTS: As field strength increases, the signal-to-noise ratio increases; consequently, more signal averages are necessary in a low field scanner. Imaging time is therefore longer. This has implications on cost effectiveness, patient throughput and image quality. Susceptibility effects are also proportional to field strength, this may be an advantage for low field scanners, but also reduces their ability to detect focal areas of calcification, iron accumulation or haemorrhage. Chemical shift artefact is also enhanced at higher fields, enabling the potential for spectroscopy. A lot of MR manufacturers have devoted much of their research to higher field scanners. This has meant that a wider range of pulse sequences and imaging options are available, especially fast imaging techniques and dynamic scanning. CONCLUSION: 1.0 1.5 T closed field systems have unlimited potential for most applications, providing higher quality images in shorter scan times. Closed systems are now being designed to be more patient and user friendly, with shorter bore lengths, patient entertainment and quieter gradients. The main advantage over lower field scanners is image quality. There are a wider variety of applications available, including dynamic scanning and newer more specialized techniques, *e.g.* EPI providing the potential for future research and a higher patient throughput.

1630
Discussion

1535–1655
Scientific Session
Targeted Radiotherapy
Hall 10a

1535
Invited Review
Modelling normal tissue complication probability for targeted radionuclide therapy
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PURPOSE: To calculate the survival of normal human haemopoietic stem cells in subjects of different ages irradiated by the α-emitters ^{149}Tb, ^{211}At (and its decay product ^{211}Po) and ^{213}Po (a ^{213}Bi decay product), which have been proposed for use in targeted radionuclide therapy. METHODS: Monte Carlo modelling was undertaken using a morphometrically confirmed model of normal human bone marrow, in which haemopoietic stem cells were randomly distributed spatially relative to fat cells (which were also randomly distributed). A trimodal distribution of normal human haemopoietic stem cell diameters obtained using image analysis was used. The decays were placed randomly in the non-fat marrow compartment, their tracks followed and dose and linear energy transfer (LET) calculated using distance *vs* energy tables [generated using Stopping and Range of Ions in Matter program (SRIM)]. The survivals of the stem cell subpopulations were calculated from the probability of surviving each passage (a function of LET). Modelling was undertaken for a range of marrow fat percentages present in adults, neonates and children and the overall weighted survival of the stem cells calculated for each age. RESULTS: The D_0 values (for decays uniformly distributed outside the nucleus, such as in neonates) were 0.81, 0.87 and 1.00 Gy for ^{149}Tb, ^{211}At/Po and ^{213}Po respectively. While the ^{149}Tb α were more effective per hit than ^{211}At, this was compensated for by the ^{211}At/Po decays hitting a greater fraction of the cells in the population than ^{149}Tb. Not allowing decays to occur in the nucleus also affected the ^{149}Tb results more than the ^{211}At/Po. As the marrow fat percentage increased with subject age, the D_0 decreased. CONCLUSION: The differences in survival of normal haemopoietic stem cells irradiated by ^{149}Tb, ^{211}At/Po and ^{213}Po were considerably less than the differences seen when the isotopes were targeted to the cytoplasm, where ^{149}Tb was five times more effective at cell killing than ^{211}At/Po in terms of α passages and nine times more effective in terms of dose.

1605
Serial quantification of ^{131}I-MIBG in patients with neural crest tumours
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^{131}I-MIBG has been used as a promising form of targeted radiotherapy in patients with neural crest tumours; however, there has been little use of imaging for the quantification of tumour uptake. In this study we have given therapeutic doses of ^{131}I-MIBG to six patients with neural crest tumours, three of whom have had serial therapeutic treatments. Patients of age range 15–66 years, four male and two female, were treated with 6.72–14.8 GBq ^{131}I-MIBG. Imaging was performed with an IGE, large field of view, gamma-camera fitted with a high energy collimator (400 keV maximum) on a single occasion 2–10 days after each treatment. Quantification of tumour uptake was assessed by measuring the count rates in regions of interest drawn around tumours, compared with the image of an ^{131}I standard. The tumour uptake was calculated to be 0.04–3.2% of the administered dose, which corresponds to uptakes of 3.0 310 MBq. The tumour volume was assessed from CT or MRI images and an estimate of the tumour dose was then made from the uptake data using Medical Internal Radiation Dose (MIRD) tables. Estimated tumour doses were 8–96 Gy. The image findings and tumour doses were correlated with the clinical outcome. As yet, quantification does not offer any real advantage over clinical or biochemical assessment and we have not gained the confidence to change treatment on the basis of this technique.

1615
Targeted radiopeptide therapy: a phase I trial of high dose ^{111}In octreotide in neuroendocrine cancers
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PURPOSE: To assess the toxicity of radiopeptide targeted therapy of neuroendocrine tumours with high dose ^{111}In Octreotide therapy. METHODS AND MATERIALS: A prospective trial was performed to assess the haematological, endocrine and renal toxicity of high dose ^{111}In Octroetide therapy for neuroendocrine tumours resistant to conventional treatment. Seven patients have received a total of 16 treatments with high dose (2–4 GBq ^{111}In Octreotide) with a minimum 3 month intertreatment interval. Five patients had disseminated carcinoid, one a medullary cell cancer of the thyroid and one a malignant gastrinoma. All patients underwent vital sign measurement and had repeated haematological and biochemical tests before treatment, then at monthly intervals. RESULTS: All patients tolerated treatment well, with only one patient having mild flushing during infusion. There were no changes in vital signs during the 30–60 min infusion of the ^{111}In Octreotide. There was no evidence of hepatic, endocrine or renal toxicity. However, in one patient there was a partially recoverable reduction in platelets after each treatment and another had a persistently low lymphocyte count. One patient died of unrelated causes after the first treatment, the remainder continue to receive regular therapy. CONCLUSION: There is no serious toxicity to high dose ^{111}In Octreotide therapy, even after repeat administrations. Therefore, a Phase II efficacy trial can now be performed.

1625
Development of new fractionated stereotactic radiation therapy cones, that can be inserted into the wedge mount
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Fractionated stereotactic radiation therapy (FSRT) is a modification of stereotactic radiosurgery (SRS), enabling conventional fractionation while maintaining mechanical accuracy using a

non-invasive and relocatable frame. We have designed new FSRT cones to overcome limitations of manufactured SRS cones. Nine new cones are 3.0–7.0 cm (0.5 cm increment) in diameter and are inserted into the wedge mount for easy handling and for taking multi-exposure Linac-grams. The mechanical accuracy of pointing to the isocentre was <0.5 mm, which was verified by ball test and cone rotation test. Dosimetry procedures included film densitometry and water phantom measurements. Beam symmetry, flatness, leakage and penumbra were all within satisfactory ranges. The quality assurance procedures recommended by manufacturers have been done only on phantoms (RLPP, LTLF, and depth-helmet), not on patients. To reinforce this, we have developed an additional novel verification procedure, which uses multi-exposure Linac-grams with the angiolocalizer attached on the Gill–Thomas–Cosman (GTC) frame. These are then digitized into the planning software (X-Knife) to generate the 3D coordinates of the isocentre for comparison. This method has been successful such that anatomical landmarks are identifiable on the multi-exposure Linac-grams and serial comparisons of the isocentre coordinates are possible with more certainty than before. This procedure has become possible with the development of our new FSRT cones inserted in the wedge mount.

1635

Using fractionated stereotactic radiation therapy for nasopharynx cancer boost and re-irradiation

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From May 1995 to April 1997, fractionated stereotactic radiation therapy (FSRT) was used in treating 19 nasopharynx cancer patients. In 13 cases it was used as a boost to primary sites (boost group), for six, locally recurrent patients, it was used as a palliative re-irradiation technique (re-irradiation group). Male to female ratio was 13:6. For the boost group, median FSRT dose was 16 Gy (8–26 Gy) after the conventional dose of 59.4 Gy (50.4–61.2 Gy), delivering a total primary site dose of 73.6 Gy (67.4–80 Gy) while, for the re-irradiation group, median FSRT dose was 50 Gy (45–62.5 Gy). Treatment planning was done on an X-Knife-3 system with a Gill–Thomas–Cosman (GTC) frame. Cone size, arc arrangement, and total arc degrees were determined individually by size and location of the tumour. FSRT doses were prescribed at 70–100% of isocentre doses and doses per fraction were 2 Gy in the boost group and 2.5–3 Gy in the re-irradiation group. 12 patients of the boost group and three of the re-irradiation group were given chemotherapy concurrently with FSRT. After a median follow-up of 18 months (6–31 months), there were two out-field failures and one in-field failure in each group. While local tumour response was judged to be excellent in both groups, three among the re-irradiation group suffered from distant metastases. There was one incidence of transient radiation myelopathy among the re-irradiation group, which occurred because the tumour was very close to the brain stem. We strongly believe that FSRT is an effective and relatively safe modality in the treatment of nasopharynx cancer, both in boost and re-irradiation.

1645

The use of registered CT and MR images in radiotherapy treatment planning

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The definition of target volumes in the radiotherapy-treatment planning of brain tumours can be a complex process. The poor definition of certain cerebral lesions on CT images often requires complementary information from other imaging modalities. It is generally considered that the enhanced soft tissue contrast demonstrated by MRI allows for much more accurate delineation of the planning target volume (PTV). Currently, radiotherapists in this centre use a combination of lateral radiographs and hard copies of both CT and MR images. A less cumbersome method is clearly required. This report describes a method of registration of CT and MR images for treatment planning purposes, using the Analyze™ AVW software package (CNSoftware Ltd). On an Ultra Sparc 2 work-station, the brain is segmented from surrounding tissues on CT and T_2 MRI image studies, both acquired after surgery. Using a 3D surface matching algorithm, the MRI brain is registered to the CT brain, producing a 4×4 homogeneous matrix describing the geometric transformation parameters required. This matrix is then applied to the complete MRI study onto which PTVs can then be defined. A software module supplied by the manufacturers allows the PTVs to be transferred to the corresponding CT image. These images are then exported to a treatment planning system for dose calculation in the usual manner. Taking the CT data as a reference, results of registration accuracy obtained from phantom and initial patient studies are presented.

1545–1800
Refresher Course & Scientific Session
Pancreas and Bile Duct
Hall 1

1545

Invited Review

Pancreatitis: imaging and intervention

P R Mueller
Massachusetts General Hospital, Boston, Massachusetts, USA

Abstract not available.

1630

Venous invasion in pancreatic carcinoma: CT–pathological correlation

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PURPOSE: In patients with pancreatic carcinoma who undergo surgical resection, tumour adhesion to the superior mesenteric vein (SMV) and portal vein (PV) requires resection and grafting of the vessel(s). Our study assesses whether the extent of tumour contact with the SMV and PV shown on CT, predicts histopathological invasion of these vessels. MATERIALS AND METHODS: Thin section, contrast enhanced CT scans of 26 patients with resectable pancreatic carcinoma were evaluated retrospectively for the length of contact between the tumour and the SMV and/or PV. An internal biliary stent had been placed in 12 patients and 21 patients had received chemo-radiation prior to CT. Contact between the tumour and the SMV or PV was considered to be present when the tumour was contiguous to the vessels without intervening normal parenchyma or a fat plane. The longitudinal and circumferential length of contact was evaluated and categorized into four groups (<10 mm, 10–19 mm, 20–29 mm, 30–39 mm). All patients underwent pancreaticoduodenectomy with venous resection. The extent of venous contact measured by CT was correlated with the presence of venous invasion on histopathology. RESULTS: 15 patients were found to have histological venous invasion; in 10 of them, contact between the veins and the tumour was 20 mm or more. One patient in this group, however, had less than 10 mm of contact. Of the 11 patients without venous invasion on histopathology, seven had less than 20 mm of venous contact, but two had more than 30 mm of contact. CONCLUSIONS: The extent of contact between the tumour and the PV and SMV does not allow reliable prediction of histopathological venous invasion. Close and lengthy contact between the tumour and venous structures does not necessarily indicate venous invasion.

1640

The dual phase spiral CT scan in the investigation of pancreatic disease

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PURPOSE: To investigate the radiological yield and clinical outcome of the first 50 patients undergoing dual phase spiral CT of the pancreas. METHODS: Case notes and films were retrospectively reviewed. The scans were performed using a standard protocol to look for small pancreatic cancers. Oral contrast consisted of 800 ml of 2% Urografin over 1 h prior to the examination. Initial non-contrast 10 mm collimation, 10 mm index, 2:1 pitch through upper abdomen, followed by injection of 150 ml of Ultravist 300 at 3 ml s^{-1}. First phase at 40 s through pancreas 4 mm collimation, 4 mm index, with a pitch of 2:1. Second phase at 65 s 8 mm collimation, 6 mm index, with a pitch of 1.5:1 through the pancreas and liver. RESULTS: To date, assessment of 50 cases has yielded 11 cases of pancreatic cancer (six on imaging grounds and five proven histologically). Of these cancers, four were less than 3 cm and potentially curable by resection. In a further three cases, an

ampullary or duodenal lesion was identified. One of these proved to be normal at ERCP, one to be chronic duodenitis and another adenocarcinoma of the ampulla on histology. Other pathology including pancreatitis was identified in nine of the 50 cases, while the results were equivocal in five cases. The remaining 22 cases showed no abnormality on the CT scan. CONCLUSION: Dual phase spiral CT of the pancreas provides a powerful method of detecting small pancreatic cancer and, at present, seems to justify the technique and use of consumables.

1650

Dynamic contrast enhanced MRI and dual phase helical CT in the pre-operative assessment of pancreatic adenocarcinoma

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PURPOSE: To compare dual phase helical CT (DPCT) and dynamic contrast enhanced MRI (DCMR) in the pre-operative assessment of pancreatic tumours. METHODS: 28 surgical candidates with a suspected diagnosis of pancreatic cancer were studied. MRI comprised FSE T_2 (TR 4000, TE 91, ETL 8), fat-suppressed T_1 weighted SE (TR 500, TE 15) and breath-hold T_1 weighted GRE (TR 100, TE 4, FA 80°) sequences before and 10, 40 and 90 s after Gd-DTPA. DPCT comprised 5 mm collimation 1:1–1.5 pitch; imaging commenced 20 and 60 s after 150 ml contrast delivered at 5 ml/s^{-1}. Four blinded observers recorded the presence of a tumour and resectability status on the basis of tumour contiguity or encasement of the major peri-pancreatic vessels, lymph node and liver involvement. Interobserver discrepancy was resolved by consensus. Results were correlated with surgery in 19 patients and consensus review in nine. RESULTS: Surgical group: CT, MRI and surgical findings were all concordant in 14 patients (12 resectable, two unresectable). In one patient vascular involvement at surgery was under-estimated by both CT and MRI. CT and MRI were discordant in four patients: tumour identified only on MRI was surgically confirmed in two patients, MRI was falsely positive for tumour in one patient and, in one other patient, MRI underestimated vascular involvement. Consensus group: full concordance between MR and CT. CONCLUSION: DPCT and DCMR both performed well in the pre-operative assessment of pancreatic tumours.

1700

Dual phase helical CT of the pancreas: comparison with endoscopic ultrasonography in the detection and staging of pancreatic cancer

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PURPOSE: Endoscopic ultrasonography (EUS) is currently considered the most accurate means of detection and local staging of pancreatic cancer. We used a dedicated dual phase helical CT scan of the pancreas, with water as the contrast agent, rapidly administered iv at 5 cm^3 s^{-1} and scanned through the pancreas and liver in both the arterial and portal venous phases. This study compared this CT technique with EUS in the detection and staging of pancreatic cancer. MATERIALS AND METHODS: 23 patients, with known or suspected pancreatic cancer, successfully underwent both EUS and dual phase helical CT of the pancreas. The findings were analysed in terms of lesion detection and vascular involvement. EUS was considered the "gold standard." RESULTS: 22 of the 23 patients had a mass identified by either EUS or CT. There was agreement between both modalities in 15 of the 22 patients. CT missed a 2 cm lesion in the pancreatic head identified at EUS (findings confirmed at surgery). However, lesions were noted at CT in six patients, in whom no mass was seen at EUS. Of these "false-positives", two were confirmed as masses at surgery and two by biopsy. In those 15 patients in whom a mass was identified at both EUS and CT, there was agreement in terms of vascular staging in only eight patients. Although CT reported vascular invasion in all the remaining seven patients, this was not identified at EUS. However, in three of these seven patients, vascular invasion was confirmed at surgery and in the remaining four patients, vascular invasion was so clearly identified by CT that surgery was not felt to be warranted. CONCLUSION: An ability of the above described dedicated dual phase helical CT of the pancreas to detect mass lesions and identify vascular involvement not otherwise seen by EUS, is suggested. Our results also suggest that there is a need for a larger study comparing helical CT with EUS, with surgery as the definitive "gold standard".

1710

Gadolinium enhanced MRI *vs* triple phase spiral CT in the assessment of pancreatic carcinoma

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PURPOSE: To evaluate the value of MRI and spiral CT in the pre-operative assessment of pancreatic carcinoma. METHOD: 35 patients with pancreatic malignancies (33 pancreatic, two ampullary), proven by ERCP brushings or guided biopsy, were imaged prospectively. Axial T_1 and T_2 spin echo and breath-hold axial and coronal FLASH images pre- and post-gadolinium were obtained. Spiral CT was performed on a dual scanner with images precontrast and during the infusion of iv contrast at 20 s (arterial phase), 50 s (pancreatic phase) and 90 s (portal phase). The images were assessed by two observers blind to the results of the other modality. The tumour site, arterial and venous vascular involvement, lymphadenopathy, peritoneal spread and hepatic metastases were recorded. These findings were correlated with findings at laparoscopy and laparotomy. RESULTS: 31/35 tumours were detected by MRI and 29/35 by spiral CT. 30 patients had laparoscopy and 20 laparotomy (7 Whipples and 13 palliative procedures). Superior mesenteric artery infiltration was not detected in one case by either modality. Superior mesenteric vein infiltration was not detected by MRI in two cases and CT in three cases. Lymph nodes were under-staged by both modalities, CT having a greater accuracy than MRI. Small liver lesions were more accurately detected by MRI (80%) compared with CT (50%). Both under-staged peritoneal involvement. CONCLUSION: Spiral CT and MRI accurately assess vascular involvement. Spiral CT is superior at assessing lymph node status. MRI is superior at detecting small tumours and liver lesions. MRI is best used to selectively evaluate cases deemed potentially operable by CT.

1720

Comparison of dynamic contrast enhanced spiral CT and MRI pre- and post-mangafodipir trisodium (T scan) in the staging of pancreatic cancer

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PURPOSE: To compare the efficacy of contrast enhanced spiral CT and MRI pre- and post-mangafodipir trisodium (T scan) in the staging of pancreatic cancer. METHOD: Imaging was performed on a GE pro-speed spiral CT scanner and a Siemens 1.5 T Vision MRI scanner. 15 patients (10 male, five female, age range 47–81) with known focal pancreatic lesions underwent contrast-enhanced spiral CT (5 mm slice pitch 1) followed by pre- and post-mangafodipir trisodium (0.5 ml kg^{-1} at 4–6 ml min^{-1}) enhanced MRI. Sequences obtained pre- and post-contrast medium were spin echo T_1 weighted, fat saturated T_1 weighted gradient echo, gradient echo T_1 weighted and T_2 weighted spin echo scans. The size of the lesion, degree of peri-pancreatic and vascular infiltration, ductal dilatation, delineation of the lesion and the pancreas were recorded. Comparison was made between spiral CT and MRI with correlation to surgery, $n=10$. RESULTS: There were no adverse reactions to administration of iv contrast. The normal pancreas did exhibit enhancement following administration of mangafodipir trisodium. *Vascular invasion*: CT correct 9/10, MRI (pre- and post-contrast) 7/10; one false negative, two false negatives, one false positive. *Peri-pancreatic invasion*: CT correct 9/10, MRI correct (pre- and post-contrast) 6/10. The primary pancreatic lesion was not identified in two patients on CT. Focal pancreatic abnormality was identified in all patients on MRI. The primary pancreatic lesion was better delineated on the T_1 weighted fat saturated gradient echo and T_1 weighted gradient echo sequences, both pre- and post-contrast. The addition of manganese DPDP offered some improvement in lesion detection on the T_1 weighted, fat saturated sequence post-contrast. CONCLUSION: Manganese mangafodipir trisodium is a safe contrast agent which does enhance the pancreas and may offer some improvement in focal lesion delineation, but it did not improve overall staging of pancreatic cancer in this small study.

1730

Is there still a role for angiography in the diagnosis of pancreatic masses?

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PURPOSE: Despite advances in CT and US it is frequently difficult to differentiate benign and malignant pancreatic masses. Biopsy may give false negative results due to sampling error. This study evaluates

the accuracy of angiography in the diagnosis of malignancy. MATERIALS AND METHODS: 37 patients with undiagnosed pancreatic masses underwent pancreatic angiography. These angiograms were reviewed by a radiologist who was blind to the final diagnosis. A diagnosis of malignancy was made if there was evidence of arterial encasement, or tumour circulation involving coeliac or superior mesenteric territory. Other features, such as displacement, dilatation or venous obstruction, were considered non-specific. The final diagnosis of malignancy was established by biopsy, laparotomy, post-mortem or development of metastases. A final diagnosis of benign disease was established by negative biopsy and absence of disease progression over a minimum of 1 year follow-up. RESULTS: There were 20 patients with malignant disease. Angiography was positive in 11 (sensitivity 55%), none of which was resectable. These consisted of nine pancreatic carcinomas and two malignant neuroendocrine tumours. There were no false positives (specificity 100%). False negatives consisted of five pancreatic carcinomas (two of which were resectable), one cystadenocarcinoma, one ampullary carcinoma, one cholangiocarcinoma and one stromal sarcoma. CONCLUSION: Angiographic features of malignancy are highly specific. Typical angiographic features may therefore confirm the diagnosis of malignancy in some cases, but sensitivity is low. Small, potentially resectable carcinomas are not reliably detected.

1740
Cholangiocarcinoma: imaging and management
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PURPOSE: To present an overview of cholangiocarcinoma, including anatomical classification, staging, management strategy and outcome. MATERIALS AND METHODS: Details of 160 patients entered in the surgical cholangiocarcinoma database in the Royal Infirmary of Edinburgh over a period of 10 years (1987–1997) were reviewed. The imaging studies and clinical outcome of the 83 (52%) patients who had pathologically-proven tissue diagnosis were reviewed. RESULTS: The average age of the 83 patients (47 males and 36 females) at presentation was 59 years. Morphologically, the majority of the lesions were stenotic. The tumour was intrahepatic in 18 cases (21.1%), proximal extrahepatic in 46 cases (55%), mid-extrahepatic in 9 (10.8%) and distal extrahepatic in 10 cases (13.1%). Surgical intervention was effected in 53 (63.9%) patients, 22 (26.5%) patients were managed by stenting only and eight (9.6%) cases were considered unsuitable for any form of intervention. CONCLUSION: Accurate classification and staging of cholangiocarcinoma depend on good radiological assessment. Cholangiography, CT scanning, angiography and laparoscopy are complementary investigations. The survival rate depends on the tumour morphology, anatomical position and subsequent management. Relevant issues in relation to management options are discussed.

1750
The role of magnetic resonance cholangiopancreatography in a range of cases
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INTRODUCTION: Magnetic resonance cholangiopancreatography (MRCP) is evolving as a non-invasive alternative examination to endoscopic retrograde cholangiopancreatography (ERCP) in the assessment of the pancreaticobiliary tree. We evaluated our local experience. MATERIALS AND METHODS: The reports of MRCPs performed on a Philips 1.5 T scanner utilizing 2D and 3D, heavily T_2 weighted turbo spin echo sequences, with a body coil and respiratory compensation on 70 patients were reviewed. Indications included biliary obstruction likely to be secondary to calculi, obstruction likely to be due a cause other than calculi, pre-surgical evaluation, post-surgical (cholecystectomy) evaluation, chronic pancreatitis, anatomy contraindicating ERCP, non-diagnostic ERCP and failed ERCP. Findings were correlated with other investigations, the results of surgery and pathological examination, when available, and clinical details. RESULTS: Technically satisfactory examinations were obtained in 65 (92.8%) cases. Primary findings (with number of cases) were: common duct stone(s) (18), gallstones (21), benign/post-operative common bile duct stricture (seven) cholangiocarcinoma (three), pancreatic carcinoma (five), choledochocyst (one), narrow, irregular pancreatic duct (five) and normal (18). There was parity in conclusions reached with other investigations and clinical details in 63 (90%) cases. In 11 (15.7%) no other imaging was required. CONCLUSION: MRCP is developing into a useful method for examining the pancreaticobiliary system. It is likely to develop a particular role in screening outpatients who do not require a more invasive assessment/treatment and in imaging those in whom ERCP is contraindicated or has failed.

1545–1645
Scientific Session
*info*RAD™ 2—Image Archiving
Hall 11a

1545
Invited Review
New storage media
J N A Ridyard
Lanmark Medical Innovations, Beaconsfield HP9 2LR, UK
New storage devices, which enable cost-effective medical imaging archives with fast, convenient access, depend upon major improvements in digital storage media capacity. The standards and technologies have been agreed over recent years and mass production of recordable digital media with capacities up to 10 times those in use today will soon be a reality. Although optical media is likely to be preferred, magnetic media is also undergoing similar cost and capacity improvements, and reliability for long-term use is acceptable. A discussion of the performance, technology and cost-effectiveness of the contenders for medical imaging archives of the next decade will be given. A comparison with film archive will also be made – will we ever see a truly filmless department? Or will we see—as with the office and publishing environments—a mix of functions, where each media is used to best advantage for differing purposes, but none truly disappear.

1615
Implementation of DICOM message exchange architecture for clinical PACS
T Kanchev
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The paper presents a programming architecture of modular configurable resources, implementing the DICOM 3.0 standard for message exchange. The problems of building message exchange systems for different medical multivendor environments are analysed. A set of library functions is described for object formatting, reading and communication of DICOM objects. Service classes are implemented in a multilayered set of routines, providing independence of the machine architecture, its data formats, the byte order, underlying network transport protocol, multithreading features etc. The system is explained in more detail with three examples: formatting of a secondary capture object, queering an image data base and print service implementation. Results from the practical use in a clinical PACS are investigated. The extendability and reliability are also discussed.

1625
Discussion

1550–1630
Scientific Session
Dosimetry
Hall 10b

1550
Fundamental quantities and units for ionizing radiation
W A Jennings
International Commission on Radiation Units and Measurements, 7910 Woodmont Avenue, Bethesda, MD 20814, USA
This presentation highlights the contents of an important new *Report of the International Commission on Radiation Units and Measurements (ICRU)* which is central to radiation metrology. Since its inception in 1925, ICRU has been responsible for the development

of internationally acceptable recommendations regarding quantities and units of radiation and radioactivity. In radiation protection, this work is carried out with the International Commission on Radiological Protection (ICRP). Since 1980, ICRU Report 33, *Radiation Quantities and Units*, has formed the basis of radiation metrology. In August 1997, following publication of a series of drafts of component Sections of comment, the Commission approved a revised version for publication early in 1998. With an improved format, this updated version includes a number of amendments and additions. Following a general introduction, the section on radiometry defines 10 scalar quantities as hitherto and introduces six new vector quantities. The third section defines seven interaction coefficients and related quantities. The fourth section, on dosimetry, now distinguishes between two categories: six quantities relating to the conversion of energy and six relating to its deposition. The former category includes the new quantity CEMA for charged particles, paralleling KERMA for uncharged particles. The final section comprises three quantities relevant to radioactivity. Unlike ICRU Report 33, the new report does not include quantities for use in radiation protection (these were published in 1993 in ICRU *Report 51*) including operational quantities. However, the presentation will make reference to the parallel ICRP protection, or dose limiting, quantities.

1600

A direct method for phantom scatter factor measurement and phantom head scatter factor determination

[1]G Leslie and [2]M Geso

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PURPOSE: Conventionally, the phantom scatter factor (Sp) is determined from the total (Sc,p) and head (Sc) scatter factor measurements (Sc,p = Sc*Sp). A new method for measuring Sp has been devised. Sp is measured directly, by varying the phantom size while keeping the collimator opening fixed. From these measurements, the Sc values are determined in phantoms that represent the actual dose due to scatter from the head of the accelerator inside the patient. MATERIALS AND METHOD: These measurements were made using 6 and 18 MV X-ray beams from a Varian Clinac 2100C. Perspex phantoms, varying in size from 4×4 to 25×25 cm, were irradiated and an ionization chamber was placed at a depth of 4.2 cm (5 cm water equivalence). Initially, the measurements were performed while the collimator opening was kept at 10×10 cm according to the basic definition of the Sp. Another set of data was obtained using a larger collimator opening to incorporate all the phantom sizes, up to approximately 30 cm. RESULTS: Our Sp data shows a variation from the existing data of about 1.5% for 6 MV beams and about 5% for 18 MV beams. Similar variations were observed for the Sc values from the in-air measurements. CONCLUSION: This new method gives a direct measurement of Sp, rather than the current approximate determination. The Sc values obtained in this method closely resemble actual clinical conditions.

1610

A Monte Carlo N-particle-based simple model of a linear accelerator X-ray beam

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The Monte Carlo N-particle radiation transport computer code (MCNP) has been used to develop a simple model to accurately simulate the major components within the beam path of a linear accelerator radiation head, namely: the electron target, primary conical collimator, beam flattening filter and secondary collimators. The model was used to calculate the energy spectra and angular distributions of the photon beam for the Philips SL 75/5 linear accelerator, along with the off-axis photon beam profiles and penumbra variation with secondary collimator positioning, perpendicular to the central axis. Direct measurement is virtually impossible. To confirm the validity of the results obtained for a nominal operating potential of 4 MV, the energy spectra depth dose distributions for various field sizes have been calculated and agree with experimental data and BJR Supplement 25 data, with $<0.5\%$ deviation. The sources of electron contamination of the photon beam and the variation with field size were also studied. Results show that the beam flattening filter is the major source of secondary electrons. The model may be used to calculate the energy spectra of any linear accelerator upon specification of the component dimensions, materials and nominal accelerating potential. The model can be readily modified to include the influence of multileaf collimation.

1620

In vivo dose measurements in electron therapy using a p-type silicon diode

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There is a steadily growing interest in the use of *in vivo* dosimeters to confirm the accuracy of dose delivery in clinical radiotherapy. A literature survey has shown that all recently published work on this topic pertains to clinical photon beams. This report deals with *in vivo* electron dosimetry. The EDD-2 p-type silicon diode (from Scanditronix AB) has been designed for use as an *in vivo* dosimeter in clinical electron beams. Before use in the clinical environment, extensive series of commissioning measurements were performed to determine the diode response with respect to variations of important beam characteristics. These included beam energy, dose per pulse and beam size. The changes of diode sensitivity with temperature and accumulated dose, and the directional dependence of the diode have all been thoroughly investigated. Using this information, correction factors have been established for use on the treatment machine and the diode has now been introduced into clinical use. Results of *in vivo* dose measurements on 100 patients treated with electron beams in the energy range 8–12 MeV are presented. After applying suitable correction factors, the difference between delivered and measured doses is less than $\pm 3\%$ in most cases.

Tuesday 2 June

0800–0850
Scientific Session
Neuroradiology 1
Hall 9

0800

Magnetic resonance angiography visualization of cerebral aneurysms

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PURPOSE: With the development of the endovascular treatment of intracerebral aneurysms, MR angiography (MRA) is playing an increasing role in the diagnosis, assessment and management of this condition. Diagnosis has relied on conventional catheter angiography (IADSA), but this is invasive and potentially dangerous. Refined MRI techniques provide a non-invasive and accurate method of demonstrating aneurysm morphology. METHODS: 30 patients with 41 intracranial aneurysms presenting with either acute aneurysmal subarachnoid haemorrhage, or symptoms related to focal mass effect, underwent both MRA and IADSA. MR studies were performed on a 1.5 T Philips ACS NT scanner, comprising a standard axial GrASE sequence through brain, 3D Fourier transform time-of-flight (FT TOF) and black blood MRA through the circle of Willis. Conventional MIP and 3D surface-rendering reconstructions were performed on a local work station (Philips Easy Vision). The two post-processing techniques were then compared with the IADSA on a one to five scale for overall image quality, aneurysm detection; neck interpretation and branch vessel identification. RESULTS: MRA was superior to IADSA in demonstrating aneurysms containing intramural thrombus, a relative contraindication to coil insertion. It provided additional information about the ostio-basal complex and branch vessel anatomy and the optimal projection for endovascular treatment. 3D surface-rendering provided better overall image quality. Black blood sequences contributed in those aneurysms with significant haematoma. CONCLUSION: 3D TOF and black blood MRA are valuable investigations in intracranial aneurysmal disease. 3D surface reconstruction provides superior image quality, allowing the optimization of projection angles during endovascular treatment.

0810

Interventional neuroradiology—in at the back door

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Femoral artery catheterization is recognized to be the safest and most commonly-used approach for endovascular treatment. Occasionally, however, either due to vascular disease, tortuous vessels, previous surgery or the specific anatomy of a particular lesion, the approach needs to be different. Newcastle's Neuroradiology Department has undertaken 888 endovascular interventional procedures since 1990. Of these, a total of 16 were embolized via a route other than the conventional femoral artery approach. These comprise one aneurysm, four spinal AVMs, four venous sinus thromboses and seven carotid cavernous/dural fistulae. The different approaches used to treat these lesions include a direct stab of the internal carotid artery, surgical access via the occipital artery, access via the brachial artery and approaches via venous routes, including transorbital surgical exposure of the superior ophthalmic vein. All of these 16 cases were embolized successfully, with no complications directly related to the procedure. This presentation comprises four selected cases which demonstrate the use of different approaches for endovascular embolization of craniospinal lesions.

0820

Embolization of cerebral arteriovenous malformations; early haemorrhagic complications following endovascular treatment

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Since 1989, 261 endovascular procedures were performed in 117 patients with cerebral arteriovenous malformations (AVMs) in our centre. This paper discusses the early post-procedure haemorrhagic complications associated with this treatment. Six patients presented acutely within 2 weeks after endovascular procedures. On CT, three patients had intracerebral haematomas with mass effect. One patient needed immediate surgical evacuation, the other two were managed conservatively. The three other patients demonstrated hyperdensity in the region of the AVM, due to progressive acute thrombosis within the AVM nidus and draining veins. Subsequent angiography demonstrated complete thrombosis of the AVM in one case and this required no further treatment. The other two AVMs were found to be partially thrombosed, but had significant reduction in the size of the nidus with a reduction in the degree of arteriovenous shunting. These were favourable features for early surgery and the planned management of these lesions was changed. The AVMs were excised on the same admission, with complete post-operative recovery. It is important to recognize those patients with hyperdensity on CT due to thrombosis rather than haematoma. Cases will be presented to demonstrate the different radiological findings and management strategies for treating these two types of haemorrhagic complication.

0830

Superior sagittal sinus thrombosis treated by local thrombolysis

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PURPOSE AND METHODS: Venous sinus thrombosis is a rare, but potentially fatal, condition that can be difficult to diagnose, both clinically and radiologically. The neurological signs and symptoms are often vague and non-localizing. The most common finding on cranial CT is a subtle generalized cerebral swelling, but the scan can be normal in up to 20% of cases. MRI and magnetic resonance venography are diagnostic. Initial treatment is systemic anticoagulation, with heparin and, in some centres, diuretics. If the patient's conscious level deteriorates despite treatment, or a focal neurological deficit develops, then local iv thrombolysis is advocated. Small amounts of tissue plasminogen activator (rt-PA) are delivered, via a micro-catheter system, directly into the sinus. RESULTS: Three patients with superior sagittal sinus thrombosis were treated using direct thrombolysis. Two patients were adults, one presented following severe mastoid infection with deteriorating vision and one immediately post-partum with decreasing conscious level. The third was an unconscious child, who presented following severe sinusitis. All of these patients were deteriorating, despite adequate heparinization. All received thrombolysis. Two patients clinically improved, one patient died of raised intracranial pressure despite treatment. No major procedure-related complications occurred. CONCLUSION: Thrombolysis is a second line method of treating superior sagittal thrombosis when conventional therapy is ineffective. Early diagnosis of this condition is important and subsequent referral to a specialist centre for thrombolysis is advocated when the patient does not respond to conventional therapy.

0840

Patterns of acute stroke on diffusion weighted MRI

G R Cherryman, D Wilcock, J Entwhistle, N Messios, A Jivan, D Newsom, J Withers, J Tranter and J Potter

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PURPOSE: Diffusion weighted echoplanar MRI allows the earlier and more confident diagnosis of acute brain infarction. We describe the different patterns of acute infarction seen on diffusion weighted MRI and the advantages and disadvantages of using this technique as a first-line investigation in patients presenting with acute stroke syndrome. MATERIALS AND METHODS: Images and case records of 100 patients admitted with acute stroke and imaged with diffusion weighted MRI were retrospectively reviewed. All imaging was conducted at 1.5 T. Comparison was made with susceptibility weighted echoplanar MRI, T_2 weighted MRI and, when available, CT and magnetic resonance angiography (MRA). RESULTS: Diffusion weighted MRI is significantly better at depicting recent infarction than T_2 weighted MRI or CT. This difference is most marked in patients with early infarction, extension of previous infarction and multiple embolic infarcts. Diffusion weighted MRI is also of value in recognizing recent events in patients with chronic cerebrovascular disease. Diffusion weighted MRI is less sensitive than susceptibility-weighted imaging in the detection of primary and secondary haemorrhage. CONCLUSION: The combination of diffusion and susceptibility weighted MRI (the 1 min stroke scan) represents a major advance in the recognition and depiction of the different patterns of acute infarction/haemorrhage seen in patients admitted with an acute stroke.

0800–0850
Refresher Course
Paediatric Congenital Cranial Abnormalities
Hall 10a

0800
Invited Review
Paediatric congenital cranial abnormalities—the skull
S Chapman
Radiology Department, Birmingham Children's Hospital, Ladywood Middleway, Birmingham B16 8ET, UK
Many congenital diseases are associated with cranial abnormalities. The presentation will begin with a review of the embryology of the skull and this will be followed by a discussion of the following conditions. Calvarial defects: enlarged parietal foramina; craniolacunia and convolutional markings; sinus pericranii; anterior fontanelle dermoid; cephalocoeles—occipital, parietal, sincipital (frontoethmoidal) or basal. Wormian bones and defective ossification: osteogenesis imperfecta; cleidocranial dysplasia; hypophosphatasia. Hyperostosis: osteopetrosis, and other sclerosing bone dysplasias. Craniosynostosis: isolated primary; as part of a recognized syndrome; secondary; postural deformities.

0825
Invited Review
Paediatric congenital cranial abnormalities—the brain
T Jaspan
Diagnostic Imaging Centre, University Hospital, Nottingham NG7 2UH, UK
A brief overview of the major abnormalities will be given. A basic understanding of the embryological milestones and consequences of their interruption is required. Genetic or chromosomal abnormalities and intrauterine adverse events (infection, ischaemia) account for 40%. Aetiology is unknown in 60%. *3–4 weeks* Brain development commences with notochordal induction of the neural plate, which invaginates to form the neural tube (dorsal induction). The neural tube closes from the middle like a zipper. Disorders—absence (anencephaly) or herniation of brain (cephalocoeles), generalized disorders include Chiari malformations and accompanying myelomeningocoeles. *5–10 weeks* The cranial end expands into three primary vesicles, the forebrain (prosencephalon), midbrain (mesencephalon) and hindbrain (rhombencephalon). Overlying ectoderm is induced to form the facial structures. The forebrain subdivides into the telencephalon, which develops bilateral cerebral vesicles, and diencephalon (thalamus, hypothalamus) with outpouchings forming the optic vesicles. Disorders—abnormalities of the brain and/or face (holoprosencephaly, septo–optic dysplasia), maldevelopment of the fourth ventricle and cerebellum (Dandy–Walker). *2–5 months* Neuronal proliferation, differentiation and histiogenesis develops. Neuronal and glial precursors proliferate from the germinal zones of the cerebral vesicles. Cellular migration commences and is largely complete by 24 weeks. Sulcation commences at 16 weeks and is largely complete by term. Disorders—cortical dysplasia, schizencephaly, grey matter heterotopia, neurocutaneous syndromes. *6 months–adulthood* Myelination is maximal between 30 weeks and 8 months, but continues along with brain maturational processes into adulthood.

0800–0930
Scientific Session
Hepatopancreatic Imaging
Hall 10b

0800
5 year experience of transjugular intrahepatic portosystemic stent shunts
P J Haslam, C Rees, M Hudson and J D G Rose
Department of Radiology, Freeman Hospital, High Heaton, Newcastle upon Tyne NE7 7DN, UK
AIM: To review the 5 year experience of transjugular intrahepatic portosystemic shunt systems (TIPSS) use in a regional liver unit. PATIENTS AND METHODS: Between 1992 and 1997, 115 TIPSS procedures were performed on 112 patients. Indications for treatment were variceal bleeding (90 patients) and refractory ascites (25). Portal venography was used for follow-up at 3 months, then 6 monthly. RESULTS: TIPSS were successfully inserted in 110 patients (96%) with a mean reduction in portosystemic pressure gradient (PPG) of 60% and median shunt diameter of 10 mm. The 30 day mortality was 13%; 67% of patients are currently alive. The rebleeding rate was 14% at 1 year and 18% at 2 years. There was no significant difference in the median PPG at which gastric (GVH) and oesophageal (OVH) variceal haemorrhage occurred (GVH 21 mm Hg, OVH 22 mm Hg) and rebleeding and mortality rates were comparable. In the group treated for ascites, mortality was 67% at 12 months and was higher in those aged >60 years, those with creatinine >200 and patients with a Childs Pugh score >10. Primary patency was 68% at 1 year (53% at 2 years), primary assisted patency 85% (63%) and secondary patency in excess of 70% at 2 years. Overt encephalopathy developed in 12% of patients, but when subjected to psychometric testing most patients showed some impairment. CONCLUSION: TIPSS has proved a valuable technique in the management of patients with variceal bleeding and in a limited number with refractory ascites.

0810
The impact of octreotide and transjugular intrahepatic portosystemic stent shunts on mortality due to variceal bleeding
C Rees, D Nylander, M Hudson, C O Record and J D G Rose
Department of Radiology, Freeman Hospital, High Heaton, Newcastle upon Tyne NE7 7DN, UK
AIM: To assess retrospectively the impact octreotide and transjugular intrahepatic portosystemic stent shunts (TIPSS) have had upon mortality in patients admitted to a regional liver unit with portal hypertensive bleeding. PATIENTS AND METHODS: Data were retrospectively collected from all patients admitted to this tertiary referral centre with gastrointestinal bleeding in two 1 year periods, before and after the introduction of TIPSS. The post-TIPSS year was chosen after 30 TIPSS had been performed, to exclude the "learning curve" effect. All patient admissions for portal hypertensive bleeding were included in this study. There were 59 admissions, 33 in the year prior to the introduction of TIPSS and 26 in the post-TIPSS year. Statistical analysis was performed using Fisher's exact test Mann–Whitney U test. RESULTS: Expressed as median values of percentage:

	Year (1990–91)	Year 2 (1993–94)	*p* value
Age	52	60	0.6
Child's Pugh score	9	8	0.2
Tertiary referral	52%	58%	0.6
Octreotide used	36%	89%	<0.01
Sengstaken tube used	48%	35%	0.3
TIPSS attempted	0%	42%	<0.01
Inpatient days	10	12.5	1
Inpatient rebleeds	12%	12%	1
Inpatient deaths	9%	12%	1
30 day mortality	9%	12%	1
6 month mortality	15%	27%	0.4

CONCLUSION: The introduction of TIPSS and the more widespread use of octreotide did not improve survival amongst patients admitted with portal hypertensive bleeding. Larger numbers of patients are required to support this finding.

0820
Transjugular intrahepatic portosystemic stent shunt: comparison of intravascular flow measurement and Doppler US
M Libicher, U Leutloff, B Radeleff, U Mädler, G M Richter and G W Kauffmann
Department of Diagnostic Radiology, University of Heidelberg, 69120 Heidelberg, Germany
PURPOSE: To measure intravascular flow velocity of transjugular intrahepatic portosystemic stent shunt (TIPSS) with a Doppler guide wire. To determine the accuracy of Doppler US as compared with intravascular flow measurement (IFM). METHODS: In a prospective study, 40 patients with TIPSS underwent follow-up with venous portography and Doppler US (3.0 Mhz). During portography, intravascular flow of the portal vein and TIPSS were measured with a Doppler guidewire. Velocity measurements were obtained in the portal vein and the portal and hepatic vein segment

of TIPSS. Doppler US was performed on the same day before portography, using the same parameters. US results were correlated with intravascular flow velocities. RESULTS: In 28 patent stents, IFM showed a mean flow velocity (MFV) in the portal vein and portal and hepatic vein segment of TIPSS of 23 ± 7 cm s^{-1}, 56 ± 21 cm s^{-1} and 86 ± 28 cm s^{-1}, respectively. Correlating US parameters were 26 ± 10 cm s^{-1} 59 ± 20 cm s^{-1}, and 88 ± 25 cm s^{-1}, respectively. The best correlation of US and IFM was obtained at the portal vein end of TIPSS ($r_s = 8, p = 0.0001$). Within TIPSS, flow velocities in the hepatic vein segment are higher than in the lower portal vein end ($p < 0.001$). In 12 stenotic cases, MFV at the portal segment of TIPSS was reduced to 24 ± 6 cm s^{-1} (IFM) and 26 ± 7 cm s^{-1} (US). CONCLUSION: Doppler US is an accurate means of determining flow velocities in patients with TIPSS. MFV increases from the portal vein to the hepatic vein segment of TIPSS. In stenotic cases MFV is significantly reduced. Valid US measurements are obtained at the portal vein end of TIPSS.

0830
Contrast enhanced colour Doppler sonography in the follow-up of transjugular intrahepatic portosystemic stent shunt

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PURPOSE: To improve the evaluation of restenosis in patients with transjugular intrahepatic portosystemic stent shunt (TIPSS) with contrast-enhanced colour Doppler sonography. MATERIALS AND METHODS: In a prospective study, 42 colour Doppler sonograms were obtained in 37 patients with TIPSS. Each examination was performed before and after iv injection of 4 g of galactose-based contrast agent (Levovist^{R}, Schering AG, Berlin, Germany). The sonograms were evaluated with regard to visibility of colour and flow in the stent using a grading score with four categories. Transjugular portal venograms of the same day were used as the "gold standard." Special emphasis was focused on the detection of stenoses in the hepatic vein end of the stent. RESULTS: Contrast enhancement showed better signals in the whole stent in 31 of 41 sonograms. Significantly better visualization of the hepatic vein end of the shunt was observed in 39 of 42 sonograms. Colour gain could be reduced for more than 10% in 34 of 42 sonograms. 11 of 13 restenoses requiring reintervention in portal venography were difficult to evaluate in sonograms and could be seen better with contrast enhancement. 11 of these 13 stenoses were located in the hepatic vein end of the shunt. CONCLUSION: Contrast enhancement in colour Doppler sonography improves the evaluation of restenoses in TIPSS. It particularly increases the signal in the hepatic vein end of the shunt, which is often difficult to visualize in native sonograms and where stenoses often occur.

0840
Assessing the efficacy of multihance (Gd-BOPTA/DIMEG) for the detection of focal liver lesions

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PURPOSE: Comparison of MultiHance-enhanced and plain MRI for the detection of focal liver lesions (FLLs). MATERIALS AND METHODS: 113 patients with suspected FLLs underwent T_1 weighted GE, T_1 weighted SE and T_2 weighted SE MRI, before and at 40–80 and 90–120 min after the iv injection of 0.05 or 0.10 mmol kg^{-1} MultiHance. Three blinded assessors recorded the number of FLLs, their location and the maximum diameter of the smallest FLL on pre- and post-contrast images. The MRI findings were correlated with the results of "gold standard" procedures (intraoperative US or CT arterial portography). RESULTS: In patients with ≤ 8 FLLs ($n = 99$), contrast enhancement allowed the detection of a higher number (+21 to 53%, $p < 0.01$) of additional FLLs, mostly subcentimeter nodules. The mean lesion size was 7–10 mm smaller post-contrast, compared with pre-contrast. Concordance with "gold standards" was significantly improved in post-contrast scans (34–35% to 49–54%, $p < 0.01$). MultiHance improved both FLL conspicuity and the assessors' confidence in detecting/excluding lesions. As a result, additional information provided by MultiHance led to changes in diagnostic conclusions in 25% of cases. No difference was observed between the two MultiHance doses. CONCLUSION: MultiHance significantly increases MRI accuracy for the detection or exclusion of FLLs.

0850
The evolution of small "indeterminate" liver lesions

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OBJECTIVE: Lesions of < 15 mm diameter are often impossible to characterize by imaging and occur frequently as incidental findings in patients under surveillance for malignant disease. This study aimed to ascertain whether specific imaging characteristics on CT could predict the behaviour of indeterminate small liver lesions. METHOD: 308 small lesions were identified in 120 patients who underwent multiple (minimum two) contrast-enhanced CT studies of the liver over a period of 6 months–5 years. The following properties were recorded for each lesion at the first occasion at which it was seen—size, shape, attenuation, edge and homogeneity. Lesions were classified into those which remained unchanged, those which enlarged and those which diminished in size or disappeared. Uncertainties in interpretation were resolved by consensus of two observers. RESULTS: 220 lesions remained static, 43 grew larger and 45 disappeared or diminished in size. There was considerable overlap in image characteristics in all three groups. However, lesions which enlarged were more likely to show unsharp margins, heterogeneous consistency and size > 5 mm when first seen. Lesion shape and attenuation were poor discriminators for benign or malignant behaviour. Some lesions with a "benign" appearance showed malignant behaviour, whilst disappearing or diminishing lesions showed both "benign" and "malignant" features on imaging. CONCLUSION: In the context of surveillance for malignant disease, small liver lesions cannot safely be ignored. Although size under 5 mm and a sharp margin are favourable features, this appearance does not exclude malignant potential.

0900
MRI of liver disease in cystic fibrosis

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PURPOSE: To evaluate MRI and magnetic resonance cholangiopancreatography (MRCP) for diagnosis of liver disease in cystic fibrosis. To correlate MRI evaluation with an established US scoring system. MATERIALS AND METHODS: 20 adult patients with cystic fibrosis were studied. MRI, including MRCP and US were performed. Appearances of the liver parenchyma, liver edge and periportal changes were recorded and scored on MRI and US, using the established scoring system. Portal, splenic and superior mesenteric vein dimensions and the direction of flow in the portal vein were recorded. The appearance of the biliary tree and CBD were recorded on MRCP. RESULTS: Seven patients imaged to date show excellent correlation between MRI and US for the presence of cirrhosis, non-cirrhotic liver disease or normal liver, using the established scoring system. In 4/7 patients MRI using a fat saturation sequence, has shown periportal echogenicity, shown on US to be periportal fat. On MRCP, the common bile duct and main intrahepatic ducts have been demonstrated in 6/7 patients, but no strictures have been identified. CONCLUSION: Our results to date suggest MRI correlates well with an established US scoring system for identifying chronic liver disease in cystic fibrosis. However, MRCP has not demonstrated sclerosing cholangitis, which is thought to be the cause of chronic liver disease in these patients.

0910
Lymphadenopathy in primary sclerosing cholangitis

K Johnson, J Olliff and S Olliff
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Primary sclerosing cholangitis (PSC) is a disease of unknown aetiology, resulting in inflammation and fibrosis of the biliary tree. Patients are at increased risk of developing cholangiocarcinoma which adversely affects their survival, especially after orthoptic liver transplantation. All CT scans of patients with PSC referred to the liver unit at the Queen Elizabeth Hospital since 1992 are reviewed. The presence and location of any lymph node with a short axis diameter greater than normal is reported. The incidence of lymphadenopathy and cholangiocarcinoma is also documented. 36 scans are reviewed, including eight with cholangiocarcinoma as well as PSC. Abdominal lymphadenopathy was present in 26 cases (66%) and 45 separate lymph node groups were involved in these patients. Five of the eight cases of cholangiocarcinoma had significant

lymphadenopathy. Follow-up of the remaining has not demonstrated the development of cholangiocarcinoma. Lymphadenopathy is commonly demonstrated by CT in PSC patients. It does not imply malignancy and should not exclude a patient from undergoing liver transplantation. Conversely, cholangiocarcinoma may develop without significant lymphadenopathy.

0920

US findings in patients undergoing extracorporeal membrane oxygenation

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PURPOSE: To perform abdominal US on all adult patients undergoing extracorporeal membrane oxygenation (ECMO) to establish if changes occur during the period on ECMO. MATERIAL AND METHOD: This is a prospective study that is being performed on all ECMO patients from April 1997. So far, 19 patients have been examined. Criteria for ECMO is the existence of severe respiratory failure, with deterioration despite maximal conventional treatment. In the UK this highly specialized treatment for adult respiratory failure is available only at Glenfield Hospital. Initially, US is performed within 24 h of admission and repeated every third day whilst on ECMO. Routine abdominal US is done on all patients and the organs are imaged for size, echotexture and focal lesions. Fluid collections and associated findings, such as haematomas, pleural and pericardial effusions, are also noted. RESULT: All the patients had abnormal liver function tests and showed significant enlargement of the liver with altered echotexture. Some had enlarged kidneys with focal lesions. Some had pleural and pericardial effusions which had to be drained. CONCLUSION: US is the only bedside imaging modality that is available to ECMO patients, apart from plain films. This study has established a baseline for the changes which occur in all patients. There are sonographic features which affect management, including liver texture changes and the early detection of fluid collection.

TUESDAY

0800–0850
Scientific Session
Thromboembolism
Hall 11a

0800

The radiology department's role in setting up an outpatient deep vein thrombosis service

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Patients with possible deep vein thrombosis (DVT) are often admitted for anticoagulation until the diagnosis can be made. If investigation is delayed, the hospital bed may be blocked. The 65% of patients who then have negative investigations will have received unnecessary treatment. Tinzaparin is a low molecular weight heparin that is administered subcutaneously and is as effective as iv heparin. It requires a once daily injection, no monitoring and has fewer complications. Some hospitals have introduced an outpatient DVT service without direct radiological involvement and have been unsuccessful. We have developed a service working closely with the clinicians to investigate and treat suitable patients entirely as outpatients. Those presenting during the working day, after discussion with the GP, attend the Radiology Department for investigation at pre-arranged appointment times. The negative cases are returned to the GP. The positive cases are referred to the anticoagulation team for counselling and treatment. The initial subcutaneous injection of tinzaparin is given by the hospital and the patient is discharged. Subsequent daily injections are given by the hospital or in the community, depending upon individual circumstances. Those patients presenting out of hours are similarly injected and discharged to return for investigation the next working day at the pre-arranged times. The flexibility to investigate these patients promptly has been achieved by skill-mix, with radiographers performing either the venography or Doppler studies. This system has reduced the wait for radiological investigation and decreased hospital bed usage. The radiographer role extension has freed up radiologists' time and improved departmental morale.

0810

Lower limb deep vein thrombosis as a surrogate for suspected PE—which imaging modality?

[1]N C Rowlands, [2]J H Reid and [1]J T Murchison
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PURPOSE: Imaging of the lower limb venous system in those with inconclusive ventilation–perfusion (V/Q) scans or non-diagnostic helical CT is recognized as a useful supplementary procedure. Some protocols advocate Doppler US as the modality of choice. However, an increasing number of studies have shown poor sensitivities for US in patients with asymptomatic limbs, with results as low as 38%. This is especially true of US examination of calf veins. We performed a retrospective review of the site of thrombus in patients who had supplementary contrast venography. METHOD: Over a 4 year period, 254 patients had indeterminate V/Q scans as recorded on our venous thromboembolism (VTE) database. 186 patients underwent venography. Those with positive results were identified and the films independently reviewed by two radiologists. RESULTS: 55 patients (30%) had positive venography, with 17 patients (9%) having isolated calf thrombus only. CONCLUSION: A significant number of patients with an indeterminate V/Q scan have demonstrable lower limb thrombus (30%). Of these, almost a third are solely below knee. These findings have significant implications for the choice of imaging modality for lower limb assessment in patients with an inconclusive lung scan. It can be seen that if US is used as the standard modality, then a significant proportion of patients undergoing further investigation will have false negative results. We recommend venography as the modality of choice in this situation.

0820

Plasma D-dimer levels—is that venogram really necessary?

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Good Hope Hospital NHS Trust, Sutton Coldfield B74 2TW, UK

PURPOSE: Clinical diagnosis of deep vein thromboembolism (DVT) is unreliable, with 50% accuracy. Thus, many patients undergo unnecessary venography. D-dimers are unique fragments derived from fibrin by the hydrolytic action of plasmin. The presence of a clot may increase D-dimer levels and normal levels of D-dimer can be used to "rule out" DVT. This was tested in a clinical setting using a rapid immunofiltration assay (NycoCard D-Dimer). METHODS: 80 consecutive patients presenting to the radiology department with a suspected diagnosis of DVT had blood taken for D-dimer testing. Citrated blood samples were centrifuged at 2 500 g for 15 min and the plasma frozen for subsequent testing. The patients then underwent duplex scanning and/or venography. NycoCard D-Dimer utilizes a gold conjugate in an immunofiltration test principle which produces a reddish purple colour at pathological concentrations. A NycoCard reader was used to estimate the concentrations of D-dimer. RESULTS: Of the 80 specimens one was rejected because of severe lipaemia. DVT was diagnosed in 29 (36.7%). The DVT positive (28 positive on test and one negative) and DVT negative (30 positive on test and 20 negative) groups were well-matched for sex and age. The test for D-dimers gave a sensitivity of 96% (only one false negative), specificity of 40%, positive predictive value of 48% and negative predictive value of 95%. CONCLUSION: A normal plasma D-dimer level can be used as an exclusion test for DVT. This would decrease the number of unnecessary venograms with their attendant morbidity, which would represent a saving of time and money for the radiology department.

0830

Pulmonary thromboembolism: the utility of spiral CT pulmonary angiography in a district general hospital

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PURPOSE: Intermediate probability ventilation perfusion (VQ) scans may represent more than one third of all examinations performed for suspected pulmonary embolism (PE). Whilst pulmonary angiography remains the "gold standard" for diagnosing PE, in practice the majority of these patients will have no further imaging, the decision to treat being based on clinical grounds. Spiral CT allows for the reliable detection of pulmonary emboli to the segmental level. This study evaluates the diagnostic utility of spiral CT pulmonary angiography following intermediate probability VQ scans. METHODS: Spiral CT angiography was performed in 38 consecutive patients with intermediate probability VQ scans, following discussion with the referring consultant clinician. The impact on patient management and clinical outcome was assessed by review

of medical records at 3 and 6 months. RESULTS: Uptake of spiral CT by clinicians was 100%. 14 of 38 patients had PE on spiral CT. In the majority of the remainder, other CT findings explained the VQ abnormalities. Anticoagulation was commenced on the basis of the CT in three patients and discontinued in 15. No new or recurrent PE occurred in untreated patients following a negative spiral CT pulmonary angiogram. CONCLUSION: In this small group of patients, spiral CT angiography enabled a definitive diagnosis of PE in a significant minority, allowing for more appropriate direction of anticoagulant therapy. Spiral CT angiography is more acceptable to clinicians than pulmonary angiography and in a district general hospital provides a feasible and more cost-effective alternative to the "best clinical guess" management of PE.

0840
Acute right ventricular dilatation: a new helical CT sign of massive pulmonary embolism?
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Right heart failure is the principal mode of circulatory collapse and death in patients with massive pulmonary embolism (PE). Since early recognition of this phenomenon may assist management, this study aimed to investigate the possibility that helical CT may simultaneously diagnose acute PE and make an accurate assessment of right ventricular (RV) impairment in those with major PE. Over an 8 month period 79 helical CT pulmonary angiograms were performed to investigate suspected PE. Definite pulmonary emboli were demonstrated in 28 (35%) patients and seven (9%) were considered to have had a major thromboembolic event, with clinical signs of haemodynamic compromise. Scans of this subgroup were evaluated using parameters derived from echocardiographic studies [maximum minor axis RV and left ventricular (LV) dimensions, RV:LV minor axis ratio and RV wall thickness]. Radiological evidence of acute right ventricular dilatation, as demonstrated by an RV:LV ratio > 1.5:1 (range 1.6:1 to 2.1:1, mean 1.8:1), was found in all seven patients. Six patients received thrombolysis, three on the basis of the CT appearance of the RV. To our knowledge, this CT sign has not been described before. We believe helical CT can reliably identify acute RV impairment, in addition to making the primary diagnosis in massive PE. This observation may also help identify those patients at greatest risk of a second fatal event and facilitate therapeutic strategy. We illustrate the CT findings with examples and present a simple method of RV assessment.

0800–0850
Refresher Course
MRI for Radiographers—MRI of the Knee 1
Olympian Suite

0800
Invited Review
MRI techniques of the knee
T R Jones
The York and North Yorkshire MRI Centre, HealthSouth, The Sir Peter Shepherd Building, Wigginton Road, York YO3 7YU, UK
This paper provides an overview of current MRI techniques in the knee. A standard MRI protocol for the knee will be evaluated. Aspects relating to: patient positioning, imaging plane, slice positioning, pulse sequence and imaging options will be discussed.

0825
Invited Review
Patella tracking
D J Wilson
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There are a variety of methods for imaging the alignment of the patella with respect to the femoral grooves. These range from skyline plain radiographs, through CT, to MRI. The questions asked by clinicians are two-fold. First, is the patella groove of normal shape and size? This can only be answered by all the techniques described above. There are a variety of methods of measurement. Secondly, does the patella sublux under load? This can only be answered if the knee is moving and loaded at the time of the examination. The majority of pseudo-cine techniques described are performed with the knee unloaded. They are therefore insensitive to this diagnosis and patients with clinically gross subluxation may appear normal. Pseudo-cine techniques are of limited, if any, clinical value. The ideal imaging technique would be for the patient to flex the knee under load whilst standing, moving at speed or climbing a staircase. A high speed imaging technique is required. It may be that the ideal technique would use fast-imaging sequences, with the patient standing in a system such as the GE "Double Donut", or a dedicated knee unit designed for examination in a standing position. This type of hardware is not readily available. In Oxford we have developed a technique that allows real-time dynamic imaging of the knee under load in a conventional high field MRI system. The patient lies in a supine position with an inflated beach ball placed between the shins and the upper surface of the core of the magnet. The patient compresses the ball and whilst air is released a sequence of images are taken through the patella. Seven sections are taken simultaneously, using a fast gradient echo technique. The cycle is repeated every 7 s. The central frame from each slab is subsequently chosen and the series of central images linked as a set of images. This may be displayed as a video loop, but is equally usefully on a sheet of laser printed film. Patella tracking studies using this dynamic technique have been shown to be sensitive to a clinical diagnosis with a high correlation in those cases where there is gross subluxation. More subtle degrees of subluxation are observed that are not seen on clinical examination. In a patient where the lateral retinaculum is slack and subluxation occurs, it is unlikely that lateral release would be of value. From the images, we can determine the relative alignment of the tibial tubical and the patella groove. Our studies have shown that there may be an association between infrapatella tendon inflammatory changes and maltracking. This is the subject of an on-going research project, the results of which will be presented at Radiology '98.

0830–1100
Scientific Session
Occupational Standards
Hall 1

0830
Invited Review
Occupational standards—establishing and developing a quality service for the future
L H Mitchell
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National occupational standards specify, from the perspective of service users, what needs to be achieved in the delivery of high quality services, irrespective of setting and no matter who is involved. They describe performance—what people are expected to do in employment. They describe what should happen—not necessarily what does happen. National occupational standards are designed to be a powerful strategic and operational tool for organizations and individuals in the health and social care sector, enabling organizations to describe and map what it is they hope to achieve, and helping people put their decisions about achievements into action in a coherent and informed way. National occupational standards are now available for a great many areas of practice in the care sector. They are being used in increasingly diverse ways, such as: linking individual and organizational development and the management of performance in the workplace; assisting the clarification and development of work-roles to meet the needs of user-centred services; providing a common language about professional activity to support more effective dialogue between professional groups, commissioners, providers of services, providers of education and training, and users of services; establishing quality standards; and facilitating the development of clearer links and relationships between academic, professional and vocational qualifications. This paper will provide a background to the development of national occupational standards and their use in the development of quality services.

0900
Invited Review
Occupational standards for the practice of diagnostic US
[1]R Fernando, [1]N Prime, [2]L Mitchell and [3]L Miller
Departments of [1]*Radiography and* [3]*Psychology, University of Hertfordshire, Hatfield AL10 9AB and* [2]*Prime R&D Ltd, 15 East Parade, Harrogate HG1 5LF, UK*
Occupational standards for the multidisciplinary practice of diagnostic US have been developed by The University of Hertfordshire and Prime Research and Development Ltd (Prime R&D), in

partnership with the South and West Regional Office of the NHS Executive, supported by the College of Radiographers. The development aimed to produce occupational standards in the practice of diagnostic US for all practitioners, whether diagnostic US is undertaken as one small part of their overall work-role, or is its main part. Functional analysis was undertaken to develop a comprehensive map of diagnostic US. This draft functional map was the starting point for determining which functional areas should be taken forward into detailed standards development. The project team worked with a wide range of interested parties to draw up a comprehensive picture of how diagnostic US is used in current practice, evaluate existing occupational standards and develop new standards where necessary. A UK-wide consultation on the draft standards was undertaken to allow input from all practitioners and organizations which might have an interest. The methods used in this project will be discussed and the standards presented. Proposals for the future use of these standards will be explored, together with examples of how they might be used in practice.

0930

How radiographers prefer to learn—the impact on continuing professional development

P S Fowler

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Little appears to be known about how post-graduate and post-diploma radiographers learn best, or which environments facilitate or impede this learning. This study identifies the factors which influence how and why radiographers learn. A learning environment preferences inventory for radiographers was designed by extracting statements relating to learning and continuing professional development from semi-structured interviews with 10 radiographers. The resultant 63 item inventory was then sent to 725 radiographers across the UK. The response rate was 53.51% ($n=388$) and the data was analysed by factor analysis. Two main factors resulted and from these an inventory of 41 items was compiled. This tool was then distributed to 620 radiographers in the South Thames Health Region, together with Kolb's Learning Styles Inventory. The useable response was 36.13% ($n=224$). Information relating to how radiographers prefer to learn and undertake learning activities has been ascertained. Kolb identifies two main approaches to both perceiving and processing information. Preliminary analysis demonstrates that most radiographers tend to learn by using their observations to develop theories and use these theories to make decisions and solve problems. A smaller number prefer to learn from new situations and to have the opportunity to reflect on these experiences. Information from this study is relevant for all those involved in nurturing the concept of life-long learning in radiography and developing continuing professional development initiatives and strategies.

0940

Clinical assessment, bridging the theory/practice gap, professional development: are professional development portfolios the answer?

H A Best

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PURPOSE: The introduction of a professional development portfolio (PDP) into the BSc (Hons) Diagnostic Radiography course at Sheffield Hallam University represents an exciting and innovative change in approach to clinical assessment, bridging the theory/practice gap and fostering professional development. This presentation examines the features of the PDP and discusses how the results of a 3 year evaluation have affected its development and modification. METHODS: The PDP was introduced into the course in September 1995. The first cohort of students undertaking the PDP agreed to take part in its long-term evaluation. The evaluation was carried out over 3 years, taking into account the students (1995 intake), clinical supervisors and visiting academic lecturers. Questionnaires and focus groups were used throughout the evaluation period. RESULTS: The findings of the evaluation are, on the whole, positive. It was discovered that the PDP was far too structured in its initial version, which had limited scope. Certain features have been removed from the PDP and others added as a result. CONCLUSIONS: Although changes have been made to the PDP throughout the evaluation process, it has evolved into a useful and meaningful tool in assessing clinical learning, demonstrating links between theory and practice, and providing the skills needed in post-qualification documentation of continued professional development. PDPs are the answer to the theory/practice gap, in conjunction with continued evaluation and modification.

0950

Continuing professional development for radiographers: should radiologists take the lead?

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PURPOSE: To establish whether an in-house programme of continuing professional development (CPD) led by a radiologist has afforded any benefits to radiographers in a single department. METHODS: A survey of radiographers in this department showed the need to establish a mechanism for medical education, primarily to allow dissemination of current knowledge and to improve job satisfaction. Further investigation revealed that the training budget for external study leave was inadequate to meet the needs of all radiographers to fulfill the recommended 35 h of educational activity annually, recommended in the Code of Practice by the College of Radiographers. In response, an in-house pilot scheme for educational activity was set up, with one radiologist taking the lead. This consisted of 1 h sessions of semi-formal lectures, primarily given by invited speakers, once a month during the lunch hour. The subject matter was varied and included the clinician's perspective in areas such as oncology, cardiology, gastroenterology and neurology, together with the basics of radiological interpretation of chest disease. RESULTS: A simple questionnaire to assess the impact showed that the programme was regarded as being very valuable by all and there was unanimous agreement for it to continue. There was also overwhelming support for the concept of regular structured feedback and of suggestions regarding subject matter and formats. A formal allowance of time during working hours towards this with minimum effort and expense was favoured. CONCLUSION: In-house programmes led by radiologists are a useful and effective contribution towards CPD for radiographers and can be implemented with minimal financial outlay.

1000

The portfolio approach to the assessment of competence in US

E McInnes

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The previous qualification in US, the Diploma in Medical Ultrasound (DMU) had no formal assessment of clinical competence which contributed to a candidate being successful in achieving the qualification. The move to postgraduate courses for US education has allowed the introduction of an innovative approach to the assessment of clinical competence. This approach has both formative and summative components, which contribute to the final award, and is an extension of the generic unit, the professional development portfolio (PDP) which has been adapted to suit a multidisciplinary student cohort in an area of specialism. This presentation discusses the philosophy behind the choice of a professional portfolio in clinical competence (PPCC) as a means of assessing competence. It will then discuss the specific content and issues raised, in terms of reflective practice and occupational standards in sonography. The presentation will discuss the evaluation of the first cohort of students and explore the opportunities for continuing professional development in this specialized area.

1010

The use of an objective structured clinical examination to measure clinical competence in student radiographers

G A Marshall and P Harris

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PURPOSE: To devise, introduce and assess the value of an objective structured clinical examination (OSCE) as a method of assessing clinical competence in 3rd year undergraduate student radiographers. This is congruent with an acceptance in education that a degree level curriculum may legitimately include "assessed" knowledge derived from work-based learning and one of the standard aims of the Dearing Report to see the historic boundaries between vocational and academic education breaking down. MATERIALS AND METHODS: Objectives relating to clinical competence in 3rd year student radiographers were devised using the former North West Regional Health Authority's "Education purchasing standards for First Post Competences" as a blueprint. The Delphi technique, a systematic collection and aggregation of informed judgements from a group of experts was utilized to achieve these concensually agreed objectives. Two, 1 h OSCE's consisting of six stations each were thus agreed, piloted and introduced to test the multi-dimensional and potentially ambiguous concept of clinical competence. RESULTS: The results achieved in the OSCE by the student radiographers will be correlated via Pearson's co-efficient

with all other methods of assessment used, both theoretical and clinical, to draw statistical inferences about the value of the OSCE in assessing clinical competence. CONCLUSION: As the statistical analysis is not yet complete, conclusions regarding the value of an OSCE as a clinical competence assessment method cannot currently be made, but the development and implementation of an OSCE for 3rd year undergraduate student radiographers has been achieved.

1020
Measuring the reliability of an assessment tool used for the clinical evaluation of student radiographers
C S Sloane
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The correct evaluation of tools used for the assessment of student healthcare professionals is an important process to ensure the competence of the individuals concerned. This study examines the various methods of clinical assessment available and describes the sources of error associated with their use. A description of strategies used for evaluating these tools is given and previous relevant work is analysed. An assessment tool used in the evaluation of the clinical competence of student radiographers from the University College of St Martin is measured for interrater (between assessor) reliability. The method involves assessors scoring video tape recordings of students performing radiographic examinations. The assessor's performance is analysed using percentage agreements and intraclass correlations. The results indicated a moderate to high degree of reliability with an overall percentage agreement of 73% and many intraclass correlations in excess of 0.7. Sources of error were identified as being mainly attributable to assessor processing of the forms. Bias errors and classification errors from ambiguities within the documentation are also identified. Methods of improving the reliability of the tool are proposed. The use of video tape recordings of student performances is a valid method of assessing reliability, although limitations are identified.

1030
"Building the bridge"—teaching social science to radiography students
K Kinmond and D McCarrick
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In 1992 the qualification for radiographers changed from diploma to degree with increasing involvement of institutions of higher education. This change reflected the national policy of the then Department of Education and Training and placed a new emphasis on life-long professional development and on education, rather than instrumental training. Among other developments to the curriculum has been an increased role for the social sciences in initial training. The subject has not sat immediately comfortably within radiography training, particularly within the practice context. Radiography practitioners supervise present undergraduates in the placement elements of their courses and are central to building the relationships between theory and practice. This paper considers the tensions that sometimes exist between social science and radiography training. It argues that social science has a great deal to offer in preparing the effective radiographer; that partnership is required between social science academic and radiography practitioner to ensure relevant training of the highest quality; and that the future of the profession is best served by the development of social science perspectives and research skills within a framework of effective collaboration.

1040
"What should I do?" Supporting ethical decision making in radiographic practice through objective reasoning
C M Ferris and H A Best
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To the uninformed observer, radiographic practice may generally appear to consist of the application of psychomotor and highly mechanical skills. However, radiography has hidden elements, one of which is decision-making. Supporting radiographic practice using an appropriate decision-making framework and relevant questioning of the ethical dimensions of practice, can increase awareness of the possible conflict that can arise between personal and professional value systems. The emphasis of this paper is on the objective components of ethical decision making in radiographic practice and will contrast the application of standard, and possibly involuntary, responses to conscious decision making within the context of professional responsibility. This paper will demonstrate that objective exploration of hidden aspects of radiography can be a useful medium for demonstrating continuing professional development (CPD). We also identify the differences between scientific and ethical decision making and explore how ethical reasoning affects justification of practice and motivation. A need for tacit aspects of practice to be supported and verbalized, by exploring the meaning of ethics within the context of radiographic practice, will be presented. General dilemmas that arise during the course of practice will be identified and ethical issues related to teamwork, issues of conscience and interpersonal skills will focus the exploration of objective, ethical decision-making. The use of reflection to support radiographers wishing to demonstrate CPD in the ethical dimension of radiographic practice will be discussed.

1050
Pan-European clinical education for undergraduate diagnostic radiographers
P Milburn
Department of Radiography, Canterbury Christ Church College, Canterbury CT1 1QU, UK
This paper describes a joint project between France, Belgium and the UK to integrate a European dimension in the education and training of undergraduate diagnostic radiographers. The project, which has been part-funded by the European Community through the Leonard da Vinci scheme aims to: facilitate the development of an educational framework within which students can develop and enhance their clinical and academic knowledge and experience through exposure to different European countries; and promote the exchange of ideas and experience between educational institutions and between clinical departments. A description will be provided detailing the planning phase, in which specific and agreed clinical learning outcomes were developed to ensure integration of the experience within the home programmes. The potential educational value of the programme is analysed and planned future developments discussed. The paper will also examine the potential problems clinical staff may face who wish to gain employment in a European country, including European legislation, requirements and disparity of qualifications. The final section will outline plans to expand the project to include Germany, Norway and The Netherlands.

0900–1130
Scientific Session
Neuroradiology 2
Hall 9

0900
Invited Review
Recent advances in endovascular treatment of intracranial aneurysms and arteriovenous malformations
A Gholkar
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Cerebral aneurysms and arteriovenous malformations commonly present with intracranial haemorrhage. If untreated, these lesions can lead to significant morbidity and mortality. Endovascular treatment of these lesions has been in practice for many years. However, developments in microcatheter/guidewire technology and the availability of new embolic agents have considerably improved our ability to treat many of these previously untreatable lesions. Improved technical ability has brought about the need for more responsibility. A definite role for endovascular therapy in the management of vascular intracranial lesions needs to be established. This paper will highlight recent advances in endovascular treatment, and will also emphasize the need for long-term follow-up and clinical research.

0930
Invited Review
Endovascular treatment of carotid stenosis and acute stroke
A G Clifton
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One of the major preventable causes of stroke is thrombo-embolism from stenosis of the carotid or vertebral arteries. Clinical trials have shown that carotid surgery is of benefit in preventing further strokes in patients with recent symptomatic severe carotid stenosis. However, surgery carries a significant morbidity. Percutaneous transluminal angioplasty (PTA) has become an established treatment for coronary and peripheral vascular disease. Preliminary

results suggest that PTA of carotid and vertebral stenosis has an acceptable complication rate and may provide an alternative to surgery. PTA requires only a short hospital stay and has the advantage of avoiding the risks of general anaesthesia, as well as the discomfort and cost of surgery. The indications of risks, benefits and results of carotid and vertebral angioplasty and stenting will be discussed. Thrombolysis, either iv or directly intra-arterially, is another technique which is under assessment, both in Europe and the USA for treatment of acute stroke. The risks and potential benefits of this new treatment will be discussed.

1000

The value of the "single visit clinic" in the investigation of headache

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Departments of [1]Radiology and [2]Neurology, Poole Hospital, Poole, Dorset BH15 2JB, UK

PURPOSE: Since 1994 Poole Hospital has operated a "single visit clinic" (SVC) for general practitioners (GPs) to refer patients with headache for neurological assessment and a CT scan, if indicated. A standardized referral form is used, seeking details of instantaneous onset (? haemorrhage), focal neurological symptoms and signs, or papilloedema, although the majority of patients had none of these features. The service was retrospectively reviewed to establish its value. METHOD: The radiology records of 234 patients attending the SVC over 32 months were reviewed. A questionnaire was sent to GPs 1 month after patient attendance to establish their opinion of the service. RESULTS: Five patients (2%) showed abnormalities on their scans requiring further neurological follow-up (one aneurysm, one meningioma, one arterio–venous malformation, one pineal cyst, one case of focal atrophy following previous subarachnoid haemorrhage). Cerebrovascular disease was found in 12 patients and sinusitis in a further two (not requiring neurological follow-up). 97% of GPs responding said that this style of clinic should be continued and 85% said that clinic assessment had assisted in the management of the patient. The majority of patients did not return to the GP complaining of headache after attending the clinic. CONCLUSION: The SVC is a very popular service with GPs with a valuable role in reassurance. The yield of pathology requiring further neurological management, from CT scanning of patients with headache, is extremely low.

1010

Evaluation of brain CT findings in psychiatric patients

M Palaniappan, K Jeyapalan and G Cherryman
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AIM: To assess the spectrum of CT abnormalities in psychiatric patients and to determine the number of cases that had an underlying cause for the symptoms. MATERIAL AND METHOD: Over a period of 15 months, from May 1996 to July 1997, 95 psychiatric patients were referred for CT brain scans. Their scans,were reviewed, along with the clinical information that was provided in the request form. All the hard copies were reviewed to assess areas of atrophy, ischaemia, infarction, structural abnormality and space occupying lesion (SOL). Atrophy was classified as mild, moderate or severe by comparing the size of the lateral ventricle and subarachnoid spaces. It was also classified as focal or diffuse. The majority of requests were to exclude vascular event or SOL. Clinical indications included confusion; memory loss; depression, with poor response to treatment; cognitive impairment; and behavioural abnormalities. RESULTS: 15 (16%) were normal. 74 (78%) had varying degrees of atrophy, ischaemia and infarctions. 5 (5.3%) had SOL which included three meningiomas and two gliomas. One patient had midline structural abnormality (persistent septum cavum pellucidum). CONCLUSION: In our series the incidence of SOL was 5.3%, compared with 0.001% of the general population. CT scanning in psychiatric patients is indicated when there is an atypical presentation, or inadequate response to standard treatment.

1020

Is a simple measure of brain volume clinically useful?

J J K Best and J E Rimmington
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PURPOSE: During brain compartment analysis in a cohort of HIV-positive patients it has been possible to test the validity and clinical usefulness of a simple measure of brain volume: the bicaudate brain ratio. MATERIALS AND METHODS: (i) A case control study of two groups of 25 patients matched by age, sex, pre-morbid IQ and date of seroconversion. Group I: patients with HIV Associated Dementia scanned within 6 months of the onset of dementia. Group II: HIV positive non-demented patients scanned at the same interval from seroconversion to dementia as their matched controls. (ii) A longitudinal study of the same groups scanned serially. All the scans were performed on the same unmodified MRI system. Total brain, grey and white matter, basal ganglia, cerebrospinal fluid (CSF) volume and ventricle volumes were measured using ANALYZE software. RESULTS: The whole brain volumes, normalized for intracranial volume and bicaudate brain ratios for the two groups, were significantly different at the time of dementia ($p<0.001$). The ventricular volumes correlated with the total CSF volumes ($r=0.74$), the bicaudate brain ratio correlated with the whole brain volumes ($r=0.61$) and the cortical and central grey matter atrophied at the same rate. CONCLUSIONS: The ventricular dilatation in brain atrophy due to HIV is an *ex vacuo* effect, due to general cerebral atrophy. Despite reservations on the use of ratio and proportion measures, the bicaudate brain ratio is a sufficiently accurate measure of brain atrophy to be clinically useful in HIV-positive patients.

1030

Determination of the response of pituitary adenomas to dopamine agonists by dynamic MRI

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INTRODUCTION: Dopamine agonists cause reversible tumour shrinkage and reduce hyperprolactinaemia in pituitary prolactinomas by mechanisms which are unclear. This preliminary study examines vessel permeability and extracellular volume in normal glands compared with dopamine agonist treated pituitary adenomas. METHOD: Seven patients with microadenomas (prolactin 2400 ± 240SEM $mU\,l^{-1}$) and four with macroadenomas (range 15 000–450 000 $mU\,l^{-1}$) and seven normal volunteers (three male and four female: prolactin $<450\,mU\,l^{-1}$) were investigated. Single slice dynamic T_1 weighted fast SPGR imaging was performed pre- and post-treatment using a 1.5 T GE Sigma system. Gd-DTPA ($0.1\,mmol\,kg^{-1}$ body weight) was injected rapidly 20 s after the start of the sequence and 100 sequential images collected with a temporal resolution of 2.4 s. The signal intensity time course for each pixel within ROI encompassing adenoma and normal tissue was analysed to provide vessel permeability, exchange rate (ER) and extracellular volume (EV). This sequence was repeated at 3 days and 3 months following up to 4 mg weekly Cabergoline for treated macroadenomas, and 75 μg daily Quinagolide for microadenomas. Normal volunteers were investigated following three daily 75 μg Quinagolide doses. RESULTS: Maximum contrast enhancement of normal pituitary gland occurred by 30 s, after which signal wash-out was observed, whereas micro-macroadenomas continued to accumulate contrast. No significant difference was observed for vessel permeability or EV in normal pituitary tissue from patients or controls at either time-point. Marked reduction in the permeability and ER of macroadenomas was demonstrated at 3 days (19.1 ± 7.3 *vs* 6.5 ± 4.3; $p<0.01$; and 37.8 ± 16.5 *vs* 17.1 ± 11.7; $p<0.01$, respectively) with further reduction at 3 months. No alteration in any of the parameters was observed for microadenomas. CONCLUSION: Dopamine agonists appear to have direct vascular effects on macroadenomas only. This possibly reflects an effect on the direct arterial supply to these tumours which is absent in microadenomas.

1040

MultiHance (Gd-BOPTA/DIMEG) in MRI of intracranial tumours

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PURPOSE: To compare the safety and efficacy of two dose levels of MultiHance in patients with intracranial space-occupying lesions as assessed by CT and/or cerebral angiography. METHODS: A total of 109 patients were included in 14 single-centre open-label, randomized parallel-group studies and received either 0.1 or $0.2\,mmol\,kg^{-1}$ MultiHance (55 and 54 patient studies, respectively). Safety was evaluated on the basis of pre- and post-contrast clinical, ECG and laboratory controls as well as 24 h patient-monitoring for adverse events. T_1 weighted SE and T_2 weighted SE images were obtained pre-contrast. T_1 weighted SE sequences were repeated every 15 min up to 1 h after $10\,ml\,min^{-1}$ infusion of either of the two doses. RESULTS: The overall incidence of adverse events was 11.0%, while the incidence of events considered to be related to contrast medium administration was 7.3%. No difference was observed between the two dose groups. No MultiHance-related serious adverse events were reported. Post-contrast increase in lesion signal intensity and normal brain/brain lesion CNR was highly significant at both dose levels. Additional lesions were observed post-contrast in 90% of patients with secondary tumours. MultiHance did not obscure any lesion detected on pre-contrast images. Post-contrast images provided significantly superior lesion visualization

and delineation than unenhanced MRI. No significant differences between the two dose levels were detected. CONCLUSION: MultiHance is a safe and effective contrast agent for MRI of intracranial lesions.

1050
Automated proton MRS of the brain at 1.0 T: reproducibility and clinical utility in Alzheimer's disease
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PURPOSE: To assess the reliability, reproducibility and potential clinical utility of an automated, single voxel magnetic resonance spectroscopy (MRS) technique at 1.0 T field strength in a district general hospital clinical MRI scanner. MATERIALS AND METHODS: Paired brain spectroscopy examinations were performed on 10 normal volunteers and in patients with clinical features of either multi-infarct dementia (MID; $n=6$) or Alzheimer's disease (AD; $n=8$) using an automated STEAM sequence (PROBE: TR/TE/TM; 1500/30/13.7 ms). Ratios of brain metabolites N-acetyl-aspartate (NAA), choline-containing compounds (Cho), glutamine/glutamate (Glx) and myoinositol (Mi) were measured relative to creatine/phosphocreatine (Cr) and assessed for intersubject and intrasubject variability. RESULTS: Values for Mean/StD/repeatability in normal subjects were NAA/Cr (1.26/0.083/0.126), Cho/Cr (0.78/0.064/0.18), Mi/Cr (0.74/0.066/0.09) and Glx/Cr (0.80/0.06/0.11). MI/Cr ratios in AD patients (0.83 ± 0.02) were significantly higher than MID (0.68 ± 0.06) patients ($T=6.48$, $p<0.0005$). CONCLUSION: This preliminary study demonstrates that this automated MRS method allows rapid and reproducible *in vivo* measurement of brain metabolites. The technique is suitable for use in the district general hospital and may play an important role in the clinical management of dementia and other neurological diseases.

1100
Comparison of the diagnostic information in relative cerebral blood volume: maximum concentration and subtraction maps based on MRI of gliomas
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PURPOSE: To investigate the validity of maximum and subtraction signal intensity maps, using simpler reconstruction modes of regional relative cerebral blood volume (rCBV). MATERIALS AND METHODS: 25 patients were studied on a 1.5 T MRI scanner. To calculate the rCBV map the MRI susceptibility effect signal intensity–time curves were treated as follows: (i) transformed into concentration–time curves; (ii) a γ variate function was fitted; and (iii) integration of the area under the curve was performed. From the concentration–time data subtraction (SUB) maps as simple image (peak change) subtraction and maximum peak concentration (MAX) maps after the γ fit were calculated. Regions of interest (ROI) were compared. RESULTS: Normal grey to white matter contrast did not show a significant difference between rCBV (2.22 ± 0.20), MAX (2.20 ± 0.18) and SUB (2.20 ± 0.46). Based on statistical evaluation, low grade lesions ($n=13$) did not vary significantly ($\alpha=5\%$, t test) in rCBV (1.24 ± 0.14), MAX (1.25 ± 0.12) maps and in SUB (1.20 ± 0.28) maps. In the group with high grade lesions (12 patients), statistical outcome showed no difference ($p>0.5$) between standardized rCBV (4.71 ± 0.63), MAX (4.31 ± 0.60) and SUB (4.27 ± 0.75) maps. SUB maps exhibit poorer image quality. CONCLUSION: Compared with the rCBV maps, the maximum maps (MAX) and subtraction maps gave a good correlation in high grade and low grade tumours.

1110
Evaluation of diffusion weighted MRI in patients with amyotrophic lateral sclerosis
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PURPOSE: To assess the diagnostic value of diffusion weighted imaging in patients with amyotrophic lateral sclerosis (ALS) in comparison with the conventional PD/T_2 weighted sequence. MATERIALS AND METHODS: Patients with ALS (10 men and two women, mean age 56 years) and 12 age-matched control subjects (mean age 54 years) were studied with diffusion weighted and conventional MRI. For diffusion imaging, a reversed FISP sequence (PSIF) (TR/TE = 23/2, 3, 5 ms; b-values 165, 288, 598 s mm^{-2}) was used. T_1, T_2, PD weighted imaging (TR/TE = 600; 2500/15; 25, 90 ms) were performed at identical slice positions in axial orientation. Images were evaluated by two readers blinded to the clinical history of ALS patients and control subjects. RESULTS: Diffusion-weighted images showed high signal intensity (higher than grey matter) in the corticospinal tract at the level of the internal capsule in 11 patients with ALS (92%) and five control subjects (42%), whereas T_2 weighted images revealed high signal intensity in the corticospinal tract in 11 patients with ALS (92%) and eight control subjects (67%). The PD weighted images disclosed high corticospinal tract signal in five patients with ALS (42%), but not in any of the control subjects. Statistical analysis showed that diffusion weighted imaging ($p=0.027$, χ^2 test) and T_2 weighted imaging ($p=0.037$), were more specific than PD weighted imaging ($p=0.317$). Subtle linear low signal intensity was found on diffusion weighted images within the motor cortex in six patients with ALS and none of the control subjects. CONCLUSION: Diffusion weighted imaging seems a promising tool compared with T_2 weighted imaging and PD weighted imaging in the diagnosis of ALS.

1120
Diffusion weighted MRI in patients with transient global amnesia
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PURPOSE: Transient global amnesia (TGA) does not exhibit a morphologic correlation in conventional MRI. The sensitivity of diffusion-weighted MRI in patients with acute TGA is evaluated. MATERIALS AND METHODS: 10 patients with onset of amnesia symptoms 12–72 h prior to investigation were examined at 1.5 T (Vision, Siemens). A diffusion weighted (DW) gradient echo sequence (PISF, TR/TE = 27/2–5 ms, b-value 165–599 s mm^{-2}), and a conventional T_2 SE sequence (TR/TE = 2500/25.90 ms) were obtained in identical coronal slices. PSIF and SE images were compared for abnormalities in signal intensity, or changes in morphology. RESULTS: Of these patients with clinically confirmed TGA, 7/10 showed elevated diffusion signal intensity in the medial hypocampal region unilaterally. 1/10 showed bilateral signal abnormality in the DW sequence and 3/10 had no observable change in DWI. Conventional T_2 imaging was normal in all patients, the size of the hypocampus and the parahypocampal fissure was unremarkable. CONCLUSION: Diffusion weighted imaging in the evaluation of TGA is more sensitive than conventional MRI.

TUESDAY

0900–1030
State of the Art Symposium
MR Spectroscopy—Approaching Clinical Reality
Hall 10a

0900
Invited Review
Magnetic resonance spectroscopy in the liver—approaching clinical reality
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This overview summarizes the role of *in vivo* hepatic magnetic resonance spectroscopy (MRS) in the diagnosis and the prognostic assessment of patients with liver disease and evaluates the prospects for using MRS in the further understanding of the biochemical basis of hepatic injury. ^{31}P has been the most widely applied nucleus in MRS studies of the liver, providing information on intracellular concentrations of metabolites critical to cell function. Changes in ^{31}P MRS detectable metabolites reflect rates of cell membrane synthesis and breakdown and cellular energy states. Insight into carbohydrate and fat metabolism may be provided by ^{13}C MRS. A wealth of animal studies and *in vitro* MRS of tissue samples and body fluids have established the biochemical basis behind spectral changes

documented *in vivo*. The applications of MRS to the study of the pathogenic mechanisms of liver disease in man have been widespread, including, for example, providing information on tumour kill following chemotherapy and assessment of carbohydrate metabolism in glycogen storage diseases. Recent studies on the isolated donor liver prior to hepatic transplantation have highlighted the potential use of MRS as a rapid, reliable means of assessing donor organ viability through non-invasive measurement of cellular bioenergetics. Measurements of hepatic function in the failing liver are often difficult and pre-operative hepatic ^{31}P MRS studies in patients with chronic liver disease have shown spectral changes which correlate directly with the severity of liver dysfunction. This suggests that ^{31}P MRS may be a useful technique in patient assessment prior to liver transplantation, but the exact clinical role is unclear, because studies to date have been limited in both their cross-sectional study design and in the relatively small number of patients studied. Future efforts using MRS should be directed into longitudinal studies to assess prognosis in patients with chronic liver disease of various aetiologies in an attempt to identify the patients likely to decompensate. Of great interest will be the evaluation of whether MRS can be used to predict patient outcome in acute liver failure.

0925
Invited Review
Magnetic resonance spectroscopy of newborn infants
A D Edwards
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The pathogenesis of brain damage in the developing brain is complex and incompletely understood, but magnetic resonance spectroscopy (MRS) has made a significant contribution, particularly to the understanding of hypoxic–ischaemic damage. Studies using ^{31}P and ^{1}H MRS have shown that hypoxia ischaemia followed by resuscitation leads not only to primary cellular injury during the period of the insult, but to a delayed secondary injury 24–48 h later. The degree of later neurodevelopmental impairment is directly related to the severity of the secondary injury. The secondary phase of injury is characterized by low [phosphocreatine]/[inorganic phosphate] ([PCr]/[Pi]) and high lactate/creatine peak area ratios, together with a high intracellular pH (pH_i). It has recently become clear that this abnormal cerebral energy metabolism can persist for months after a hypoxic–ischaemic insult, and the high cerebral lactate and pH_i probably represent a change in redox potential in neural cells, either as a result of mitochondrial impairment caused by the injury or possibly as part of a repair response. The changes in MRS are consistent with data acquired by MRI. Soon after an insult, diffusion weighted images are abnormal, while conventional T_1 and T_2 images become abnormal some days later. Weeks after hypoxia ischaemia, brain structure shows significant alterations, including both the development of atrophy distant from the original site of injury, and in some cases accelerated growth in areas of focal infarction. The mechanisms of secondary and more delayed brain injury probably involve cellular injury mediated by excess concentrations of excitatory neurotransmitters, free radical formation and lipid peroxidation, activation of immune mechanisms and removal of trophic factors which normally support cell survival. Recent studies have emphasized the importance of apoptosis after hypoxia–ischaemia; a considerable proportion of cells die not by necrosis but by apoptosis, and the number of apoptotic cells is directly related to the severity of changes in cerebral energy metabolism determined by MRS. The period between resuscitation from hypoxia–ischaemia and secondary injury offers the potential for therapeutic interventions to ameliorate delayed damage and concomitant neurodevelopmental impairment. Many potential interventions are being investigated, including drugs which block the toxic actions of glutamate, or prevent apoptosis, and moderate hypothermia applied following resuscitation. MRS has been used to demonstrate that such treatments applied after hypoxia–ischaemia prevent the development of secondary phase of injury.

0950
Invited Review
Magnetic resonance spectroscopy in oncology
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The first MR spectra of a tumour in a patient were reported in 1983 and many studies have since been published. How far are we towards routine clinical use? This paper considers three areas in which MRS is likely to be applied: diagnosis and grading, monitoring response to therapy and drug pharmacokinetics. DIAGNOSIS AND GRADING: Tumour diagnosis usually involves histological examination of a biopsy; decisions are inherently subjective and not always clear-cut. MRS diagnosis of brain tumour type and grade without a biopsy would clearly be useful and promising results have been obtained using pattern recognition analysis of H MRS spectra. Such spectra can now be acquired by push-button methods in routine radiology. However, if this facility is to be widely used, radiologists must learn how to interpret this completely new form of information. ASSESSING TUMOUR RESPONSE TO THERAPY: At present, the only way to predict the outcome of most chemotherapy, radiotherapy etc., is to wait for the tumour to grow or shrink; ^{31}P MRS detection of chemical changes could have an important role. The phosphomonoester peak increases in size if a tumour is growing and falls rapidly (before measurable tumour regression) in response to successful therapy. A multicentre trial of this method is now in progress. PHARMACOKINETICS *IN SITU*: ^{19}F MRS has been used to measure the pharmacokinetics of the anticancer drug 5-fluorouracil *in situ*, in the tumour, both in animal models and in patients. In clinical studies, tumours destined to respond lost the drug signals more slowly than resistant tumours. Recent laboratory studies suggest that this mechanism is pH-dependent and can be enhanced by adjuvants, such as interferon. Anticancer drugs containing other nuclei can also be detected (^{31}P, ^{13}C) so pharmacokinetics *in situ* might have a more general application in trying to select the best treatment.

1015
Discussion

0900–1030
State of the Art Symposium
Japanese Radiology Now
Hall 11b

0900
Invited Review
Role of CT and MRI for staging lung cancer
M Kono
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CT and MRI images can play an important role in the staging of lung cancer. Assessment of a solitary pulmonary nodule is most commonly achieved using CT. High-resolution CT is particularly useful for identifying morphology and attenuation characteristics of a solitary nodule. On the other hand, MRI can play a clinical role in some cases of lung nodules. On contrast-enhanced MRI peripheral lung cancer tends to be enhanced more strongly than benign nodules, but the enhancement degrees of lung cancer and benign nodules overlap each other. Therefore, MRI has a limitation for differentiating lung cancer from benign nodules. Determining the extent of the primary tumour and lymph nodes metastasis is indispensable for planning treatment. In particular, in patients with an endobronchial tumour and/or pleural invasion, 3D CT can give more information for treatment planning than conventional CT. MRI can also be useful for determining tumour invasion of the chest wall, including the thoracic inlet and mediastinum. MRI is also more accurate than CT in the diagnosis of invasion of the great vessels in the mediastinum. Hilar mass and its peripheral pulmonary disease can be distinguished on the T_2 weighted images, or on contrast-enhanced MRI. At present, both CT and MRI have similar accuracies and capability for staging lung cancer. However, in certain situations, MRI may be superior to CT.

0925
Invited Review
Recent advances in liver imaging—CT and MRI diagnosis of nodular lesions complicating in liver cirrhosis
K Ohtomo
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Hepatocellular carcinoma (HCC) is the fourth commonest malignancy in Japan, after cancer of the lung, stomach and colorectal region. 60–80% of livers bearing HCC have cirrhosis following viral infection. Hepatocellular carcinogenesis in cirrhotic patients is a multistage process. The spectrum of nodular lesions in these patients ranges from benign to malignant. The lesions include regenerative nodules (RN), dysplastic nodules [adenomatous hyperplasia, (AH)], early HCC and classic HCC. CT and MRI manifestations

of classic HCC, which are familiar even to radiologists in western countries, consist of internal mosaic appearances, surrounding fibrous capsules and abundant blood supply via the hepatic artery. Early HCC is defined as a nodular lesion consisting of very well differentiated cancer cells, frequently with a portal structure, Kupffer cells and fatty changes. CT and MRI appearances of early HCC are quite different from those of classic HCC. They are usually hypovascular, without mosaic appearances and thick capsules. AH is a hyperplastic lesion with portal blood supply. Fatty changes and iron deposits are frequently seen. Pathological examinations are still required for a conclusive differential diagnosis between early HCC and AH. In this lecture, our CT and MRI strategy will be presented for the detection and diagnosis of these nodular lesions complicating liver cirrhosis, techniques include conventional dynamic study, CT during arterial portography (CTAP) and the use of liver-specific MRI contrast materials.

0950
Invited Review
Arterial embolotherapy for haemoptysis caused by benign diseases
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PURPOSE: To assess the efficacy of bronchial and other systemic arterial embolotherapy for haemoptysis caused by benign diseases. METHODS: Bronchial and other systemic arterial embolotherapy was performed on 109 patients with persistent or relapsing haemoptysis caused by benign diseases, including chronic tuberculosis, bronchiectasis, pulmonary Aspergillosis, lung abscess, pneumoconiosis, etc. The embolizations were performed using a combination of polyvinylalcohol (Ivalon) particles and gelatin sponge cubes. Angiographic and clinical findings were reviewed. RESULTS: Inflammatory neovascularity, systemic pulmonary shunts and non-bronchial systemic vascular supply were commonly seen angiographically. Haemoptysis stopped immediately after the initial embolization in most of the patients, but six (6.4%) had recurrent haemoptysis within 1 month after embolotherapy. Minor traumatic complications occurred on bronchial arteries in five patients, but there were no major complications, such as myelopathy or oesophageal ulcer. Among 71 patients who were observed for 1 year or longer, recurrent haemoptysis occurred in 13 patients (18.3%) and these patients had repeat embolotherapy, or surgical treatment. 11 patients with recurrent haemoptysis had non-bronchial systemic arterial supply to the lung lesions and the recurrence rate was particularly high among those with pulmonary Aspergillosis (4/6). CONCLUSION: Embolization of the bronchial and other systemic arteries is a safe and effective method of treating persistent or relapsing haemoptysis caused by inflammatory pulmonary diseases. Long-term haemostatic effects can be expected in most of the cases. But patients with non-bronchial systemic arterial supply to the lesions need close follow-up, because the recurrence rate is relatively high.

1015
Discussion

0900–0950
Refresher Course
MRI for Radiographers—MRI of the Knee 2
Olympian Suite

0900
Invited Review
Ligaments of the knee—MRI radiographer's guide
C R Kendell
MRI Department, Northampton General Hospital, Northampton NN1 5BD, UK
This paper provides an overview of the ligaments of the knee. Anatomy, scanning planes, pulse sequences and common pathological appearances of the ligaments will be covered.

0925
Invited Review
Meniscal tears
P M Cavanagh
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MRI has now established itself as the primary imaging tool in investigating meniscal tears and associated pathologies. However, there are many pitfalls of image interpretation for the inexperienced. To avoid such errors a sound knowledge of the relevant anatomy is essential. There are a number of normal structures in close relation to the menisci that can mimic meniscal tears (*e.g.* popliteal tendon, menisco–femoral and transverse geniculate ligament). Following discussion of the relevant anatomy, the MRI features of meniscal pathology will be outlined. The grading of meniscal signal is well-established and the relevance of this grading will be explained. It is no longer sufficient to diagnose a meniscal tear. Once noted, the type of tear becomes important to the orthopaedic surgeon. Tears are broadly divided into horizontal and vertical. Horizontal tears are usually degenerative in origin and can be found in the asymptomatic population, whilst vertical tears are usually post-traumatic and may require surgical intervention. Current surgical thinking is to try to preserve the integrity of the knee joint and to carry out meniscal repair, or even treat conservatively where possible. If surgical excision is necessary this is often only limited. Thus, vertical tears can be further divided into bucket-handle, radial, parrot's beak, peripheral and meniscular separation. The appearances and management of these various forms of tear will be discussed.

0915–1000
Refresher Course
The Spine
Hall 11a

0915
Invited Review
MRI of the spine post-operatively and spinal infection
M T Modic
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The greatest cost connected with low back pain is in patients who have pain longer than 3 months and those with recurring disabling episodes. Upwards of 5.2 million people are disabled by back pain, recurrences of pain occurring in 60–85%. Low back pain is the most expensive health care cost in patients between 20 and 50 years of age. In particular, the failed back surgery syndrome is a particularly troublesome disorder and its incidence appears to be on the rise. Imaging evaluation in this group plays a critical role, as surgical outcome appears to be related to morphological alterations found at the time of operation. These are findings that are best predicted pre-operatively by imaging with MRI. The causes of failure of spine surgery may be divided into early and delayed. Causes of early failure including hematoma, infection, insufficient decompression, insufficient removal of herniation, root trauma, unrecognized free fragment and wrong level surgery. Causes of delayed recurrence of low back pain and/or sciatica pain include arachnoiditis, epidural fibrosis, facet degeneration, instability, new herniation, pseudo meningoceal, stenosis and vertebral osteomyelitis. This session will focus on the role MRI plays in the evaluation of patients with the failed back surgery syndrome and its relationship to surgical outcome.

0945–1015
Keynote Lecture
Targeted Radiotherapy
Hall 10b

0945
Invited Review
Modelling tumour control with targeted radiotherapy
T E Wheldon
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Targeted radiotherapy differs from external beam irradiation, in the role played by emitted particle range, the time-dependence of dose rate and the heterogeneity of dose deposition. Therefore, modelling

of tumour control probability is a more difficult task for targeted than for conventional radiotherapy. Nevertheless, modelling of tumour control has provided some robust conclusions, which suggest guidelines for therapeutic strategies. The modelling studies imply that curative therapy of disseminated disease will require high dose combination treatments, including both radionuclide and external beam irradiation, and provides some rules for the relative magnitudes of the components. Radionuclide cocktails can be designed which should be superior to any single radionuclide. Most existing treatments using targeted radionuclides do not conform to these guidelines and are not expected to be curative. Therapeutic strategies, predicted by modelling studies to be potentially curative, have now begun to be studied clinically. These clinical studies will eventually provide a means of testing the predictions of the models. In future, it is likely that new biological innovations, such as gene therapy, will impact on both targeted radiotherapy and external beam treatment. Here too, modelling studies can be useful in setting goals to be achieved by biotechnology, in order that gene transfer makes a significant clinical difference. Modelling of tumour control provides a useful tool for the current design of therapeutic strategies and for the evaluation of new approaches.

1015–1115
State of the Art Symposium
The Future of Fractionation Practices
Hall 10b

TUESDAY

1015
Invited Review
Outstanding issues in radiotherapy dose fractionation studies
J H Hendry
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There are many outstanding issues regarding the optimization of dose fractionation schedules, some of which will be discussed. Issues include: (i) Is there good evidence for a low fractionation sensitivity of some tumour types? (ii) Can low-dose hypersensitivity be exploited? (iii) What are the lag periods and time factors for tumours other than head and neck? (iv) Do gaps in conventional treatments matter as much as in split courses? (v) Does the position of a gap matter? (vi) Why is the response to dose fractionation of some tumours influenced more by hypoxia than in others of the same type? (vii) How prevalent and important is biphasic repair? (viii) Can doses be safely escalated as a result of modifying early reactions? (ix) Is there a time factor for some late-reacting normal tissues? (x) Can late reactions be modified sufficiently to allow dose escalation? (xi) Are there optimum treatment schedules for specific tumour types? (xii) What is the influence of heterogeneity on fractionated dose/response relationships? (xiii) Can heterogeneity in response be exploited to improve outcome? (xiv) What is the optimal way of combining brachytherapy with external beam treatments? (xv) What degree of benefit will conformal radiotherapy provide? (xvi) Is there a role for biology in treatment planning?

1045
Invited Review
The fractionation of external beam radiotherapy
M I Saunders
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Over the past 20 years there have been many studies involving the novel fractionation of radiotherapy. In all these experiments the aim has been to increase local tumour control, with a tolerable acute morbidity and without increase in late morbidity. Randomized controlled trials carried out by the European Organization for Research in the Treatment of Cancer (EORTC) demonstrated that by hyperfractionating treatment the total dose could be raised and local tumour control improved in head and neck cancer, without increased late tissue damage. Further studies incorporating hyperfractionation in head and neck cancer are currently underway, under the auspices of the Radiation Therapy Oncology Group (RTOG). Two randomized controlled trials of accelerated radiotherapy were published this year. Both aimed to shorten the overall duration of treatment, in an effort to overcome cellular proliferation. The EORTC study published by Horiot in *Head and Neck Cancer* maintained a high total dose and resulted in an improvement in local tumour control, which was offset by increased late morbidity. In the Continuous Hyperfractionated Accelerated Radiotherapy (CHART) studies in head and neck cancer the total dose was reduced and gave equal local tumour control, but reduced morbidity. This study helps to confirm the role of repopulation in treatment failure, with a dose of 0.55 being required to overcome repopulation after day 24. The CHART trial in non-small cell lung cancer gave a significant improvement in survival and calculations would suggest that 54 Gy in 12 days is equivalent to 68 Gy given over 49 days. Two other methods of accelerating radiotherapy, namely the concomitant boost and accelerated treatment with a split, form part of the randomized controlled trial detailed above, currently being conducted in the USA. Now is the time to review all these trials and make a recommendation as to the most optimum scheduling of radiotherapy for each site.

1015–1150
Refresher Course & Scientific Session
Pelvic Malignancy
Hall 11a

1015
Invited Review
The use of MRI in staging and post-treatment evaluation of female pelvic malignancy
J M Hawnaur
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MRI is the imaging technique of first choice for staging carcinomas arising in the uterus. A combination of coronal and axial T_1 weighted spin echo, with sagittal and oblique T_2 weighted fast spin echo sequences, provides a multiplanar display of the extent of tumour within the cervix or body of the uterus, an accurate estimation of tumour volume and shows invasion of adjacent viscera and abdomino–pelvic lymphadenopathy if present. MRI is particularly valuable for determining the operability of clinically bulky tumours. Assessment of tumour volume and the presence of lymph node metastases may also be helpful in planning treatment in patients receiving radiation therapy. The role of MRI in staging assessments of primary tumours of the ovary, vagina and vulva is less well-established, but it may contribute to individual cases where clinical US or CT examinations are inconclusive. MRI is also appropriate for the evaluation of pelvic masses arising in pregnancy. In patients treated surgically for pelvic malignancy, MRI can differentiate post-operative fibrosis and recurrent tumour on the basis of signal intensity differences on T_2 weighted sequences. Its ability to separate recurrent tumour and post-treatment changes in patients treated by radiotherapy is not as good, radiotherapy-related inflammation and tumour both having increased signal on T_2 weighted and post-contrast T_1 weighted sequences. The use of dynamic gadolinium chelate-enhanced sequences does not significantly increase the ability to differentiate radiotherapy-induced inflammation and recurrent tumours. The development of open magnet systems, breath-hold sequences and magnet-compatible biopsy devices have the potential for biopsy of masses of indeterminate nature to be performed under MRI guidance.

1035
Invited Review
Role of CT in staging and post-treatment evaluation of female pelvic malignancy
J E Husband
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Although MRI is superior to CT for staging uterine malignancy, CT still has a useful role, frequently providing sufficient information for management decisions. CT is more than 90% accurate for staging advanced tumours and therefore complements clinical staging. In endometrial cancer, contrast-enhanced CT is helpful for defining tumour extent in advanced tumours, although the technique is less accurate than MRI for early stage disease. The overall accuracy of CT is approximately 85%. In both endometrial and cervical cancer, CT can detect nodal metastases in the pelvis equally as well as MRI, but has the advantage that the abdomen can readily be examined

as well. Ovarian cancer spreads transcoelomically and deposits are found on the peritoneal surfaces, diaphragm, omentum and within the mesentery. Subcapsular liver metastases and paraaortic lymph node involvement are common. Currently, these abdominal and pelvic sites of metastases are best demonstrated on CT, but staging laparatonomy remains essential to identify deposits <5 mm in diameter. CT also has a role in the diagnosis of ovarian malignancy, by detecting and characterizing pelvic masses. Post-treatment evaluation of gynaecological malignancy is an important aspect of imaging. Whilst CT cannot differentiate tumour from fibrosis on the basis of CT attenuation, recurrent tumour can frequently be diagnosed on the basis of its site, morphology and invasion of adjacent structures. Currently, CT remains the best technique for biopsy of pelvic masses.

1100

MRI features of normal and metastatic inguinal lymph nodes

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PURPOSE: Inguinal lymph nodes may enlarge secondary to pelvic or lower limb inflammation, making palpation of the groins unhelpful in detecting metastases. Pre-operative diagnosis and anatomical localization of metastases would facilitate groin dissection and reduce morbidity in radical surgical treatment of cancers of the perineal region. This study assessed whether MRI can identify inguinal node metastases in carcinoma of the vulva. METHOD: The MRI technique was developed in normal volunteers and subsequently applied pre-operatively to patients with vulvar cancer, allowing comparison of MRI findings with pathology. Coronal T_1 and axial T_2 weighted sequences were obtained of the perineum and pelvis in the body coil of a 1.5 T Philips ACS scanner. High spatial resolution coronal T_1 weighted spin echo and fat-suppressed T_2 weighted sequences were then obtained of both groins, using an 8 cm circular surface coil centred on the symphysis pubis. RESULTS: On high resolution MRI of the inguinal regions, normal lymph nodes were of reniform shape, with a fatty hilum, uniform thickness of peripheral nodal tissue and an intact capsule. Round nodes of any size completely or asymmetrically replaced by soft tissue signal intensity (low on T_1 weighted, intermediate on T_2 weighted sequences) were considered to be malignant, especially if the capsule was disrupted. These features corresponded to histopathological findings of metastatic lymphadenopathy in patients with vulvar cancer. An equivocal category, where there was uniform thickening of nodal soft tissue with preservation of a normal shape and outline, was seen in reactive lymphadenopathy. CONCLUSION: MRI is of potential value for surgical planning in vulvar cancer.

1110

US guided cytology of inguinal nodes in vulval cancer

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PURPOSE: To assess the role of US-guided fine needle aspiration cytology in predicting inguinal node involvement prior to surgery in patients with vulval cancer. The overall aim was to try to limit unnecessary groin node dissection in these patients, who are often old and frail. The traditional management of vulval cancer is by vulvectomy and bilateral radical inguinal node dissection, which carries a high morbidity. MATERIALS AND METHODS: 38 sequential patients referred to this hospital for management of vulval tumours were assessed clinically and sonographically for the presence of involved lymph nodes prior to surgery. Groin US with guided cytology of abnormal and normal nodes, was undertaken. Patients were then treated with standard surgery according to clinical stage of disease and the results of groin node histology post-operatively were compared with US findings and cytology. Patients not undergoing groin node dissection were followed up for a minimum of 1 year. RESULTS: 38 patients were scanned and, of these, 61 groins were aspirated. In 53 groins the US result concurred with subsequent histology and benign follow-up where surgery was not undertaken. Of the nine remaining groins, five had a false positive US and four had a false negative US. There were no false positive cytologies and two false negative cytologies. CONCLUSION: US with guided cytology is an effective pre-operative procedure in vulval cancer and can be used to predict inguinal nodal involvement in most patients. The pitfalls of US and reasons for inaccuracies in this pilot study will be discussed.

1120

The effects of a progestogen on the endometrium of long-term users of Tamoxifen treated breast cancer patients using transvaginal scanning and MRI

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AIMS: Tamoxifen reduces breast cancer recurrence in post-menopausal women, but is associated with an increased incidence of hyperplasia, polyps and cancer. It is postulated that Tamoxifen exerts a pro-oestrogenic effect on the uterus and that the resulting proliferative endometrial changes may be reversed by progestogens. The aim of this pilot study is to determine whether a progestogen-impregnated intrauterine coil device (IUCD) reduces endometrial thickness (ET) and volume (EV) in women on Tamoxifen, as determined by transvaginal scanning (TVS) and MRI. METHODS: Six post-menopausal breast cancer patients, mean age 62 (range 53–73), who had taken Tamoxifen (20 mg daily) for a mean of 4.5 years (range 2.3–10) volunteered after TVS had demonstrated thickened irregular endometrium. Fat suppressed T_2 weighted FSE MRI and TVS (ATL Ultramark 4; 5 MHz probe) were performed pre-treatment to assess endometrial thickness and volume. Following hysteroscopy, an IUCD containing Levonorgestrel was introduced, which delivered 20 μg progestogen daily. Further TVS and MRI examinations were performed at 1, 3, 6 and 12 months pre-IUCD insertion. RESULTS: The mean ET pre-IUCD insertion was 8.6 mm (5–12), whilst the mean EV was 2.9 ml (1.5–4). TVS failed to identify a unified response to progestogens at any of the time points examined. However, although MRI demonstrated a variable response at 1 month, at 6 months all patients showed a significant decrease in EV (mean -0.06 ml. 95% confidence interval -0.08–1.1, $p=0.03$) relative to the 3 month scan, with preliminary data at 12 months demonstrating further reduction. Substantial reduction in number and size of subendometrial cysts was noted in two patients. CONCLUSIONS: Preliminary MRI results indicate a reduction in EV and subendometrial cysts by 6 months after treatment, but further studies are required to confirm the potential clinical utility. The inconclusive TVS findings presumably reflect the limitation of a single dimension measurement.

1130

Comparative efficacy of Lumirem and Magnevist Enteral in pelvic MRI

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PURPOSE: To compare in a prospective randomized trial the efficacy of a negative (Lumirem) and a positive (Magnevist Enteral) MRI contrast agent for the delineation of the gastro-intestinal tract and neighbouring structures in pelvic MRI. MATERIALS AND METHODS: 30 patients with pelvic malignancies underwent MRI after oral contrast administration (Lumirem: 14 patients, Magnevist Enteral: 16 patients). After the administration of bowel relaxant, five T_1 and T_2 weighted pulse sequences were performed. Images were analysed for marking and distension of the bowel, conspicuity of the bowel wall, delineation of neighbouring structures and for the presence of contrast-related artefacts, using a five-grade scale. RESULTS: No significant differences in gastro-intestinal marking/distension, conspicuity of bowel wall or delineation of neighbouring structures was observed between the two contrast agents. Complete bowel marking was obtained in 10 (71%) patients with Lumirem and eight (50%) with Magnevist Enteral; conspicuity of the bowel wall was good in 71% and 81% respectively. Good delineation of neighbouring structures was noted in 11 (78%) patients with Lumirem and in 13 (81%) patients with Magnevist Enteral. Contrast-related artefacts were more frequently seen with Lumirem ($p=0.0001$), particularly on gradient-echo pulse sequences. The efficacy of the contrast agent and the presence of artefacts were sequence-dependent. Overall, the T_1 weighted gradient-echo (FLASH) sequence gave the best results with both contrast agents. CONCLUSION: Both contrast agents are effective in marking the bowel and for demonstration of pelvic structures. Contrast-related artefacts did not decrease iconographic quality or diagnostic information in most cases.

1140

MRI in radiotherapy planning of the pelvis

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PURPOSE: To incorporate MRI scans of the pelvis into the radiotherapy planning system. To identify useful and relevant sequences to enable more accurate tumour delineation. MATERIALS AND

METHODS: 20 patients undergoing routine radiotherapy treatment-planning for tumours of the prostate or bladder were selected. Informed consent was obtained. In addition to the standard CT scan used for planning their treatment, these patients underwent an MRI scan of the same region. Patients were scanned in the radiotherapy treatment position on a special table insert with MR markers placed on their tattoos as in CT. A variety of sequences in different orientations were performed for review by the oncologists. RESULTS: A suitable sequence with minimum distortion that could be corrected for geometric distortion was identified. After correction these images were transferred to the radiotherapy planning computer. These were then viewed alongside the CT scans by the oncologist to identify the target volume to be treated. Other sequences useful for delineating the target volume were also identified. CONCLUSION: Planning scans can be corrected for geometric distortion and successfully transferred to the radiotherapy planning computer for viewing alongside CT images. MRI can be used in place of radio-opaque contrast and fluoroscopy to enable the apex of the prostate to be accurately identified. A sagittal midline image was found useful for bladder tumours and coronal images were identified as being most useful for prostate localization.

1015–1145
State of the Art Symposium
MRI for Radiographers—Future Applications
Olympian Suite

TUESDAY

1015
Invited Review
Functional MRI and human brain mapping
A Brennan, H Gallagher, O Josephs, A Howseman, R Turner and R S J Frackowiak
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The rapid advance in MRI technology has led to the development of a powerful tool, functional MRI (fMRI). fMRI allows the non-invasive investigation of human brain functions, based on fast image acquisition techniques, most commonly echo planar imaging (EPI) and FLASH. Both techniques measure the endogenous changes in the vascular concentration of deoxyhaemoglobin, while measuring the MRI signal by rapid continuous imaging of the brain. Its main applications to date are pre-surgical brain mapping, epileptic focal mapping and functional brain mapping. The Wellcome Department of Cognitive Neurology is a dedicated unit for the investigation of the function and organization of the normal and dysfunctional human brain. Imaging is performed with both fMRI and positron emission tomography (PET), supporting a broad range of research including language, attention, memory, vision, psychiatry and pharmacological studies. PET is still considered the "gold standard" of functional brain mapping but, due to the greater temporal and spatial resolution, greater image averaging capabilities and the possibility of serial studies on individuals, great interest is being shown in fMRI. The optimization of our sequences and parameters and the use of blood oxygenation level dependent (BOLD) contrast will be discussed, as well as the problems associated with fMRI—subject and physiological motion and susceptibility artifact. Finally, examples of current studies, experimental procedure, presentation of the stimuli, analysis and interpretation of the results will be described.

1040
Invited Review
Interventional magnetic resonance—the way forward at St Mary's Hospital, London
A Gwynne Davies
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In October 1996, St Mary's Hospital, London installed an open super-conducting magnet for all aspects of interventional research. The magnet is a GE Sigma SP 0.5T. This configuration of vertical and horizontal access shows how MRI can provide excellent soft tissue resolution, flow characteristics, sensitivity to tissue temperature changes and multiplanar facility for image guidance of therapy. It has introduced new physical features, such as: vertical and horizontal accessibility to the patient; gradient windings made of superconductive niobium tin; larger central bore space; two perpendicular positions for patient-table entry and attachment for an in-bore chair; liquid crystal monitors in the bore for immediate image viewing at the machine side; and easy access flexible transmit receive coils for all parts of the body. Software features include fast gradient echo sequences, which allow scanning at a rate of one image every 2 s, near real-time imaging, specialized image guidance software (flashpoint tracking), controlled by a hand-held probe that the operator can manipulate and continual image guidance and monitoring during complicated surgical procedures. The unit is developing research in minimally invasive procedures, such as image-guided therapy of thermal ablations, guided needle biopsies; surgical applications, such as the introduction of the endoscope in a magnetic field; and kinematic studies of sports injuries in joints. This allows effective localization, visualization and direct access to the patient's pathology with minimal complications and limited periods in hospital, plus resultant cost-benefit with decreased morbidity.

1105
Invited Review
Medico-legal MRI
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MRI has rapidly assumed a pivotal place in the investigation of acute and chronic disease, achieving this position because it is non-invasive and highly accurate. It may come as a surprise but the investigation of a medico-legal case mirrors the clinical investigative pathway with the exception that the person directing the investigation is a lawyer who may well have only the sketchiest idea of the medicine involved. Until recently MR has assumed a secondary role but has now started to assume its correct place as an early and important investigative tool. The very nature of legal practice means that referrals for MR are expert based and the medico-legal practice of one expert will differ hugely from that of another. This talk will therefore illustrate my own field of neuroradiology; I cannot cover any other area of medico-legal practice. Examples will be drawn from cases of non-accidental injury, cranial and spinal trauma, and most particularly from cases of cerebral palsy and birth injury.

1130
Discussion

1045–1215
State of the Art Symposium
Medical Infrared Imaging
Hall 10a

1045
Invited Review
Recent advances in infrared imaging systems
M J Bosworth
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Infrared imaging, or thermography, is a well established technique used in a wide range of applications. These include medical, veterinary, research and development, industrial condition monitoring and process control. For many years infrared cameras have been based on cooled, single element detectors mechanically scanned onto the field of view to produce the image. Recently, multielement focal plane array (FPA) detectors have eliminated scanning systems to produce smaller, lighter cameras. The latest developments have been in uncooled FPA detectors providing further opportunities to reduce size and weight and increase the potential applications.

1105
Invited Review
The development of quantitative infrared imaging
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INTRODUCTION: The concept of human body temperature indicating health or disease is as old as medicine. Thermometry took several centuries to evolve from Gallileo to Fahrenheit, with limited and imprecise instruments. Wunderlich established a clinical thermometer in 1868 and showed the value of serial recordings. In the 1960s ex-military technology was introduced, which was not designed for quantitation. The advent of image-processing in the

1970s opened up the possibilities for standardization of technique and measurement. New infrared (IR) technology gives stable, high resolution images, which are quantified to better than 0.1°C. IR imaging objectively measures body surface temperature because human thermoregulation depends on heat transfer from the skin and underlying pathology can affect local blood perfusion. These changes are quantified, to measure response to treatment *e.g.* oral anti-inflammatory or vasoactive drugs. METHOD AND RESULTS: In a study of 600 patients it has been shown that high thermal indeces (TI) measured at peripheral joint sites of >3.5 occur in active rheumatoid disease, less severe in osteoarthritis and low (<2.5) in normal joints. Changes in thermal index applied to arthritis, local inflammation and Paget's disease of bone (TI 5–6.0) will be shown in response to drug therapy. A cold-stress test has been established to quantify Raynaud's phenomenon and peripheral sympathetic dysfunction, which uses the thermal gradient of the hands to derive a stress index (+3.0 to −14°C).

1125
Invited Review
Infrared imaging in venous disease
J R Harding
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Deep vein thrombosis (DVT) presents a major clinical problem, with significant risk of morbidity and mortality from pulmonary embolism if not diagnosed and treated. Clinical investigation is notoriously unreliable, but the most commonly used investigations have disadvantages. Venography is invasive, expensive and exposes the patient to ionizing radiation and risk of contrast allergy, dislodging of embolus, cardiac failure, nephrotoxicity and actual causation of DVT. Doppler US avoids these risks, but is not always available and is operator dependent and time-consuming. Infrared imaging has virtually 100% sensitivity for DVT and, when normal, (which is the situation in over a third of clinically-suspected cases) can avoid the need for venography or Doppler US. Clinical detection of incompetent perforating veins is inaccurate and tourniquet tests offer little accurate information as fascial defects may yield false positive results. Venography and Doppler US have the disadvantages already discussed. Infrared imaging can be used in the initial localization of incompetent perforating veins, so that Doppler US evaluation can concentrate just on these areas, saving scanning time. Infrared imaging can be used in its own right for pre-operative marking of varicose veins. Healing of venous ulceration can present a difficult clinical problem, especially if complicated by infection. Though severe infection is clinically obvious, early or mild infection can be difficult to confirm, in this situation infrared-imaging is useful in evaluating inflammation around the ulcer and in following progress and response to treatment.

1145
Invited Review
Infrared imaging in repetitive strain injury and reflex sympathetic dystrophy
B L Hazleman
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Infrared thermography can be useful in the assessment of patients with algodystrophy and repetitive strain injury. 10 consecutive keyboard operators with chronic forearm pain, together with 22 asymptomatic controls, were assessed for thermographic changes using the infrared talytherm unit and thermal emission measurement software (Rank Taylor Hobson). RSI was defined in this study as forearm pain present for at least 3 months without a known cause (with specific exclusion criteria). Measurements were taken at rest and after typing for 5 min, under controlled conditions. There was a statistically-significant decrease in temperature in all 10 patients. Pre- and post-test readings were significantly different in eight patients at $p<0.001$, two patients were significantly different at $p<0.01$. All but five controls either warmed up, or remained unchanged. The mean cooling in the controls was 0.77 (range 0.42–1.4), while the mean cooling in patients was 2.13 (range 0.39–5.02). The inter-group basal reading means were not statistically significant, but post-typing readings reached statistical significance at $p<0.001$. 33 patients with undiagnosed chronic knee pain had features of autonomic disturbance. The patients lacked the thermographic symmetry observed in 16 normal controls. This symmetry returned with resolution of the pain. Recognized radiological and scintigraphic features of algodystrophy were found in these patients. Temperature differences between corresponding areas of the lower limbs were significantly greater in the patients with knee pain than controls at the knee, shin and calf, but not the thigh. 10 patients had experienced substantial improvement in pain and they also showed a reversion to normal in their thermal symmetry. There was no such reversion to normal thermal symmetry in patients whose symptoms persisted, although the degree of asymmetry did vary from one examination to another.

1205
Discussion

1100–1150
Scientific Session
*info*RAD™ 3—Transmission, Teleradiology & Telemedicine—*in association with CAR*
Hall 11b

1100
Invited Review
Telemedicine and teleradiology: applications, technologies and legal aspects
H U Lemke
Technical University Berlin, Institute for Technical Informatics, 10587 Berlin, Germany
Telemedicine and, specifically, teleradiology service providers are increasing in numbers. This is partly because of advances in enabling technologies, but also as a result of the improvement in the legal and reimbursement situation. Telemedicine can be applied to a wide array of medical activities, supporting diagnosis, therapy, education and general healthcare. Technically most demanding are teleradiology, because of spatial and temporal image resolutions, and telesurgery, because of safety and real-time requirements. The total cost of ownership (TCO) of a telemedicine work-station should, of course, be minimized and, although direct digital radiography and PACS may provide a good basis for teleradiology, other technologies are also impacting telemedicine services. Of particular interest are video-conferencing standards, MPEG2, wavelet compression, DICOM, XDSL, multi-media technologies, including ATM, and the Web. Legal aspects involve regulations relating to transmission and archiving of patient data in network systems, as well as licensing certification, reimbursement, etc. Changes in the legal situation to more easily accommodate telemedicine are only slowly forthcoming, for example in the European Union, but also on a national level, *e.g.* in Germany. In the short and medium term, however, telemedicine will involve the management of risk.

1130
Implementation of a browser-based medical image viewing system
R T Black, M P Hayball and R A R Coulden
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A system has been constructed which allows medical images to be viewed over a network using a common commercial web browser program. A server automatically inserts the images into web pages which can be displayed on a standard PC. Additionally, the system integrates a database of patient demographic data, enabling the return of images in response to database queries and the collection of distributed patient information into a single web document. Problems of low network bandwidth are catered for by converting the large medical image format into the compact JPEG standard image format. Many-frame angiography studies are included by turning them into multimedia standard "movie" files. Modality-specific image display issues (*e.g.* windowing of a CT image), are dealt with by server-side programs. Updates to the image display can be made following re-specification of such parameters within the web document. Access to medical data can be controlled down to patient level and beyond by taking advantage of Windows NT NTFS password features within the browser. The system is a step towards a secure electronic patient record, accessible network-wide, which brings together in a single document all relevant patient data, including image studies from different modalities, possibly even from different medical fields.

1140
Discussion

1115–1250 Refresher Course & Scientific Session **Uroradiology** Hall 1

1115
Invited Review
Imaging and management of patients with acute renal failure
M J Kellett
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The questions to be answered when a patient presents with acute renal failure (ARF) are: (i) Is this acute or acute on chronic renal failure? (ii) Is this medical or surgical? (iii) Is it pre-renal, renal or post-renal? Clearly an acute, potentially reversible cause will prompt the clinician to pull out all the stops to support the patient until the kidneys recover. A patient with an acute episode on top of chronic end-stage renal failure presents a different problem. This paper concentrates on patients presenting with potentially reversible ARF. Imaging is at the centre of the diagnosis and the most important method of imaging is US which will firstly demonstrate the size of the kidneys. Normal or swollen kidneys may be due to a proliferative or necrotizing problem, either from a multisystem disorder or one only affecting the kidneys. It may be due to a deposition of protein, such as in multiple myeloma, or due to acute tubular dysfunction, better described as vaso-motor nephropathy. The second important question asked of US would be to detect or exclude obstruction. Less than 1% of cases will have obstruction with no clinical suspicion from the history but, conversely, 15% of all cases of ARF in some patient populations may be due to obstruction. The presence or absence of obstruction is therefore the most important question asked of the diagnostic radiologist and one which we must not get wrong. If US shows dilatation, this is obstruction until proved otherwise. Even minimal "visualization" of the collecting system must be viewed with suspicion. The pitfalls of US and the role of interventional radiology will be discussed.

1200
Primary antegrade ureteric stenting—success rate, technical factors and cost advantages
U Patel
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PURPOSE: Conventionally, antegrade ureteric stenting is performed after a few days of nephrostomy drainage because of ureteral tortousity and mucosal oedema. Primary stenting promises cost and bed occupancy savings and has been studied prospectively. METHODS: Patients with obstructive hydronephrosis were studied. Calyx for puncture were selected using air contrast guidance, and stricture entry was gained using shaped catheters, curved hydrophilic wire and torque device (first choice equipment) and a stent was inserted over a stiff wire. A nephrostomy was left to tamponade the track. Additional equipment was used when necessary. End-point measurements: successful ureteric stenting, (fluoroscopic and/or clinical assessment), procedural time and complication rates. The cost advantages and technical aspects were evaluated. RESULTS: So far, 25/34 ureters (Group 1) have been successfully primarily stented. Haematuria lasted a median of 2 days. In 20/25 cases the nephrostomy was removed within 1 day. Chronicity of obstruction, ureteral tortousity or access route (upper *vs* lower pole) did not influence success. First choice equipment alone was successful in the majority of cases (15/25). Additional equipment frequently used included VanAndel dilatation catheters and peel-away sheaths. Hydrophilic catheters, balloons and shapable wires were rarely necessary (6/25, 1/25, 1/25, respectively). The remainder (9/34: Group 2) stented successfully as a second procedure—after a mean of 4 days external drainage. Screening time was (mean) 17 min (Group 1) *vs* 13 min (Group 2). In this hospital there was a minimal saving of £600 per successful patient. CONCLUSIONS: The majority of obstructed ureters (74%) can be stented without preliminary drainage and using simple equipment. Chances of success cannot be predicted from premorbid factors. Improvement in bed occupancy and per patient costs is significant.

1210
Advantage of air contrast for percutaneous nephrostomy in infected systems
G J O'Sullivan and U Patel
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PURPOSE: Minimal contrast should be used to opacify high pressure, infected pelvicalyceal (PC) systems, yet the posterior calyces require large volumes of contrast. We have been injecting air, in addition to iodinated contrast, to improve visualization of the posterior calyces. METHODS AND MATERIALS: While performing nephrostomies the pressure in the PC system was measured before and during injection of iodinated contrast and air. In addition, we determined what volume of iodinated contrast and then air was required to opacify the most posterior calyx such that it was adequately visualized for definitive puncture. RESULTS: 31 patients have been studied so far. The average pressure rise noted after injecting 10 ml of air and then iodinated contrast was 4 and 14 cm of water respectively. The posterior calyces were satisfactorily opacified in only 13 of the 31 patients using iodinated contrast; they were seen in all patients using much smaller volumes of air. CONCLUSION: Air, used in conjunction with a small volume of iodinated contrast, is superior to iodinated contrast alone in visualization of the ideal calyx for PCN. This is of particular significance in high pressure, infected systems as it diminishes the chance of bacteraemia.

1220
Prognostic factors for the development of renal impairment in chronic pyelonephritis
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Previous studies of chronic pyelonephritis (CPN) have suggested that a poor prognosis is associated with bilateral disease, hypertension and proteinuria. We have re-evaluated these criteria in patients from our CPN database who presented with a plasma creatinine $\leq 90\ \mu mol\ l^{-1}$. 151 patients had a plasma creatinine (Cr_p) $\leq 90\ \mu mol\ l^{-1}$ at presentation (mean $77 \pm 1\ \mu mol\ l^{-1}$). Compared with the 131 patients who presented with a $Cr_p > 90\ \mu mol\ l^{-1}$ (mean $164 \pm 9\ \mu mol\ l^{-1}$) there was no significant difference in mode of presentation, but the $Cr_p \leq 90$ group were younger at presentation (30 ± 1 *vs* 36 ± 1 years, $p < 0.01$) and there were fewer males (male, 7/female, 122 *vs* male, 29/female, 102). At presentation, 28 patients in the $Cr_p \leq 90$ group were hypertensive, compared with 41 in the $Cr_p > 90$ group ($p < 0.05$) and fewer patients had bilateral disease (42 *vs* 88, $p < 0.001$) or proteinuria on urinalysis (22 *vs* 67, $p < 0.001$). In the long term, nine patients in the $Cr_p \leq 90$ group developed a plasma creatinine $> 110\ \mu mol\ l^{-1}$, but in only two was this greater than $130\ \mu mol\ l^{-1}$ and both patients had bilateral disease and proteinuria at presentation. The prognosis for patients with chronic pyelonephritis with a plasma creatinine $\leq 90\ \mu mol\ l^{-1}$ is excellent, especially for those with unilateral disease and no proteinuria. These findings may result in cost-savings by reducing out-patient follow-ups and additional imaging.

1230
CT appearance of the adrenal gland in ACTH-dependent Cushing's syndrome
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Departments of [1]Diagnostic Radiology and [2]Endocrinology, St Bartholomew's Hospital, West Smithfield, London EC1A 7BE, UK
PURPOSE: ACTH-dependent Cushing's syndrome may be caused by a pituitary adenoma (85%) or an "ectopic" ACTH secreting tumour, both causing adrenal hyperplasia. Two histopathological types of hyperplasia are recognized, diffuse and nodular (micro- and macro-nodular subtypes). The frequency, type and degree of adrenal hyperplasia that may be observed at CT is unknown. We describe the spectrum of adrenal CT appearances in ACTH-dependent Cushing's syndrome. METHODS: We reviewed the adrenal CT scans of patients with active Cushing's syndrome, performed 1989–96. Measurement of the body, limbs and largest nodule for each gland were made. Hyperplasia was diagnosed if two parts of the gland measured >95th centile for the normal size range, which we have previously defined: body (right 6, left 8 ± 2 mm) and limbs (3 ± 1 mm). RESULTS: 51 patients (33 female: 28 male), median

age 44, range 11–77 years) were studied (pituitary Cushing's $n=40$, ectopic ACTH-secreting tumour $n=11$). Mean widths for the body, lateral and medial limbs in the pituitary-dependent group were: right 8.6, 4.1, 4.4 mm; left 10.3, 5.1, 5.1 mm, respectively. Corresponding measurements for ectopic ACTH-secretion group were: right 14.3, 7.0, 7.7 mm; left 16.6, 8.0, 7.6 mm. Hyperplasia was seen in 26/40 (65%) pituitary-dependent and 10/11 (91%) ectopic ACTH-dependent patients. 13/51 (25%) patients showed nodule(s), (mean size 19.8 × 14.9 mm). Patients with ectopic ACTH secretion showed larger adrenal gland ($p<0.05$) and higher cortisol levels, than pituitary-dependent Cushing patients. CONCLUSION: 36/51 (71%) of patients with ACTH-dependent Cushing's syndrome showed adrenal hyperplasia with nodules in 25%. ACTH-secreting ectopic tumours produced greater adrenal hyperplasia than pituitary adenoma.

1240
The value of US contrast media in the assessment of testicular pathology
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PURPOSE: To determine the usefulness of galactose-based iv contrast media in the US detection of scrotal pathology. MATERIALS AND METHODS: 20 patients referred from urology out-patients had a baseline sonogram with colour and spectral Doppler. Each patient, following the administration of Levovist iv at 1–2 ml s^{-1} had repeat scrotal colour and spectral Doppler sonography performed. Comparison of both scans were made by three independent radiologists. RESULTS: 12 patients had scrotal pathology; torsion (two patients), epididymitis (three patients) epidymo-orchitis (four patients), testicular tumour (two patients) and hydrocoele (one patient). In all cases, Levovist improved identification of the pathology, allowing greater confidence in radiological diagnosis. There was no adverse response to Levovist. CONCLUSION: The use of Levovist, a stabilized microbubble contrast agent for US examination of the testes, is a promising new development that may improve the diagnostic utility of scrotal US by dramatic enhancement of the Doppler signal from testicular vasculature.

1130–1300
State of the Art Symposium
Fractionation
Hall 10b

1130
Invited Review
Experimental fractionation using very small doses per fraction
M C Joiner
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Cell and tissue response can increase at low doses relative to doses or doses per fraction greater than 1 Gy. This is called hyper-radiosensitivity (HRS). The linear quadratic model, which successfully predicts radiation response above 1 Gy, substantially *underestimates* the effect of both single and fractionated X-ray doses < 1 Gy. Data on 14 human cell lines of differing radiosensitivity show that it is the most resistant cell lines which demonstrate this phenomenon to the greatest degree. For radiotherapy, a possibly adverse consequence of HRS is that very small doses of radiation delivered immediately outside the target volume could produce greater than expected subthreshold damage to normal tissues, requiring more conservative dosing when those regions are subsequently retreated. However, there could also be a positive benefit: since HRS is more pronounced in the most radioresistant cell lines, the use of "ultra-fractionation" with small doses per fraction less than 0.6 Gy, or protracted treatment at very low dose rates < 10 cGy h^{-1}, might provide a way to treat the most refractory tumours more effectively. For example, *in vitro* studies predict that in a human glioma model (T98G), radiotherapy with 0.4 Gy fractions, three times per day to a total dose of 73.5 Gy, would be equivalent to giving 125 Gy in 2 Gy fractions whilst dose to critical late tissues would be equivalent to 63 Gy in 2 Gy fractions. Therapeutic gain in this case would effectively double.

1200
Invited Review
Fractionation in radioisotope therapy
V R McCready
Department of Nuclear Medicine, Royal Marsden Hospital and Institute of Cancer Research, Sutton, Surrey, UK
Apart from radioiodine therapy for differentiated thyroid cancer, there is relatively little experience in fractionation of therapy delivered by unsealed sources. In the last few years new therapies have come into clinical use, including MIBG and labelled octreotide. Unlike external beam therapy, the radiation is administered by systemic administration, with a varying amount of radiation being delivered to bone marrow and other body organs. This is related to the half-life and emissions of the radionuclide. In some situations the timing and dose/activity is determined by the response of the bone marrow, while in others the main factor is the balance between tumour kill and its regrowth. Additional problems in radionuclide therapy include the difficulty of determining the dose delivered to the tumour as a whole and intratumourly. The calculated doses are much greater than those usually encountered in conventional radiotherapy. Until the doses are more accurately known it will be difficult to correlate dose with response and therefore determine the optimum fraction. This presentation will review and discuss current protocols for unsealed source therapy.

1230
Invited Review
The economics of fractionation
R G Dale and B Jones
Radiation Physics and Radiobiology, Hammersmith Hospitals NHS Trust, London W6 8RF, UK
The costs of radiation therapy may be influenced by modifications to treatment technique, particularly since the improvements in tumour control have the potential to be translated into longer term cost savings for the healthcare purchaser. Radiobiological models, which assess how tumour cure probability (TCP) depends on fractionation, have been combined with financial parameters related to the cost of delivering the various types of treatment. The result is an economic model which enables the extra costs of near-optimal radiotherapy to be balanced against those sub-optimal alternatives which are more likely to be associated with further radiotherapy, salvage surgery and continuing care. A number of cautions must be observed in exercises of this nature but, in terms of the whole cost of supporting a patient from first radiotherapy treatment onwards, radiotherapy utilizing fractionation patterns which are tailored to particular sub-populations of tumour may often be associated with the lowest global cost. Such modelling can also be used to examine the consequences of the other changes in the way radiotherapy is performed, *e.g.* the cost–benefit aspects of tumour dose escalation resulting from conformal techniques.

1200–1245
Royal Society of Medicine
Finzi Lecture
Hall 9

1200
Eponymous Lecture
Breast cancer—which patients should have radiotherapy?
M Overgaard
Department of Oncology, Aarhus University Hospital, Nørrebrogade, DK 8000, Aarhus C, Denmark
There is accumulating evidence that effective loco-regional treatment in women with early breast cancer is not only important for local control, but also has substantial impact on survival. The loco-regional treatment often comprises a combination of surgery and radiotherapy. In this respect radiotherapy is indicated after breast-conserving surgery in low risk patients, with the aim of preserving the breast, and the target includes only residual breast tissue. The indication for radiotherapy after mastectomy is more unclear. This is due to a lack of a precise definition of the aim for such treatment. Post-mastectomy irradiation reduces loco-regional recurrences significantly, and this might be a sufficient indication for this treatment. However, the aim of radiotherapy has also been to improve overall survival, but in this respect the results have been disappointing with only minor or no effect on overall survival. The explanation for this could be, that post-mastectomy irradiation has been evaluated in trials including a mixture of low risk and high risk patients of all

ages, where the possible survival benefit would be of a different magnitude. In addition, there has been a large variation in the target definition, total dose and fractionation in these trials, and this would also influence the outcome both in terms of tumour control and long-term radiation related toxicity. Recently, radiotherapy has shown substantial benefit in loco-regional control and survival in two large studies including pre-menopausal high risk patients, who were also treated with adjuvant chemotherapy following mastectomy. These studies interpret that residual inadequately treated loco-regional disease can be a source for secondary dissemination, and that it is important to give both effective loco-regional and systemic treatment to achieve optimal long-term results in early breast cancer. Results from the Danish breast cancer trials, DBCG 82b and 82c, including pre- and post-menopausal high risk breast cancer patients, comparing irradiation after mastectomy plus adjuvant systemic therapy with adjuvant systemic therapy alone, will be presented and discussed with respect to tumour control and treatment related morbidity. Detailed information about the efficacy and morbidity of radiotherapy in relation to different patient characteristics, extension of surgery, timing and intensity of systemic therapy are necessary to find precise indications for radiotherapy in early breast cancer.

1200–1250
Scientific Session
Digital Radiography
Hall 11b

1200
Novel film viewing technology and the EC '96 Radiology Quality Guidelines

D Inbar and A Rippel
Smartlight Ltd, Nesher, Israel

The European Guidelines on Quality Criteria for Diagnostic Radiographic Images and diagnostic paediatrics set new milestones in quality radiography in general and in film reading device requirements in particular. This scientific presentation reviews the psychophysical basis behind those standards and demonstrates a new device, the Digital Film Viewer System (DFV) that fully complies with and surpasses the EC '96 guidelines. The device provides adaptive back illumination, seamless digital image masking, white or blue colour rendering, adaptive ambient illumination and film scatter suppression—all automatically. Preliminary clinical evaluation demonstrates the marked improvement in lesion detectability associated with this device. Each paragraph of Chapter 1, Clause 11 of the European Guidelines is presented and its psychophysical rationale is discussed.

1210
Direct radiology—first practical experiences

D L Richardson and S Barrow
Radiology Department, Royal Victoria Infirmary and Associated Hospitals NHS Trust, Newcastle upon Tyne NE1 4LP, UK

Direct radiology (DR, Sterling Diagnostic Imaging) is a new method of direct image capture, converting X-ray energy into electrical signals. The detector array "plate" is housed in the modified X-ray film cassette stand. The electrical signals produced are immediately sent to a monitor for the image to be displayed and then to a work-station, laser printer etc. The early experiences from a radiologist's perspective will be discussed and comparisons with more conventional imaging systems made.

1220
The impact of digital radiography on a domiciliary chest X-ray service

J C C Elford, J D Hunter, D E Defreind, G K L Tai, C Roobottom and I P Wells
Directorate of Imaging, Derriford Hospital, Plymouth PL6 8DH, UK

PURPOSE: To assess the impact of the introduction of a digital radiography system on a domiciliary chest radiograph (CXR) service in terms of image quality and retake rates. METHOD: A Todd Research Domiciliary X-ray unit was used in both limbs of the study. Optimal exposure conditions were initially obtained using a CXR phantom. Subsequently, 25 conventional CXRs were performed using a focus–film distance (FFD) of 1 m and an exposure time of 0.5 s; these were processed in the usual manner. A further 25 films were performed using the Fuji FCR AC-1 which comprises a photostimulable phosphor X-ray plate and digital processing which optimizes the image. Films were taken with a FFD of 1.5 m with an exposure of 0.2 s. Both sets of films were assessed for coverage, exposure, movement blur, image quality and the need for repeat films, by three observers. RESULTS: All the assessed parameters were improved using the AC-1 system. Coverage was optimal in 50% and adequate in 42% of digital films. Of the conventional films, only 13% were optimal and 39% were adequate. Sub-optimal exposures were reduced by 44%. Movement blur was reduced by 33%. Overall image quality was better and the retake rate was reduced by a factor of six. CONCLUSION: The AC-1 system produced better images than a conventional screen system. Its wider exposure latitude and post-processing produced better images, despite the low output of the domiciliary unit, and allowed the use of more advantageous imaging parameters (longer FFD and shorter exposure).

1230
Environmental and ergonomic considerations for a multiple computed radiographic facility

D Baker, B Furphy, K Foord and N Tomlinson
Department of Radiology, Conquest Hospital, Hastings TN37 7RD, UK

PROBLEM: Within a filmless "processing area" it is necessary to site: radiology information system terminals; computed radiography (CR) data input units; flat bed scanners, to digitize request form details; CR plate readers: CR image review stations; PACS viewers; and back-up laser imager(s). It may also be necessary to include: network cabinet(s); a laser imager and all the associated power points; un-interruptible power supply devices; work surfaces; cupboards; and computer network terminals. These all have to be positioned so that there is minimal personnel cross-traffic. Lighting levels, temperature control, magnetic fields and wall colourings all have to be appropriate for the task. SOLUTION: The potential flows of personnel entering, exiting and permanently working in the processing area were assessed. Equipment was placed to minimize movements across the room and new working practices instituted and evaluated. This involved assessing radiographer team work to sequentially take, check and print (send) images, rather than the conventional methodology of position patient, take process and check film quality before releasing the patient. VDU lighting regulations were enforced, with ambient lighting at appropriate levels for soft-copy viewing. Heat source calculations, including personnel as heat sources, were made and the area air-conditioned. Magnetic field strength was also a consideration in placing CR units. It was noted that adjacent MRI units may need additional shielding. RESULTS: Our multi-CR redevelopment will be presented, showing the iterative process required to achieve a satisfactory working environment.

1240
Single point of failure avoidance in a multiple CR/PACS network

K Foord, D Baker and N Tomlinson
Department of Radiology, Conquest Hospital, Hastings TN37 7RD, UK

PROBLEM: The single computed radiography (CR) unit of the 1992 Conquest PACS development proved to be a substantial single point of failure. At least one CR unit must be available 100% of the time to avoid switchback operation of PACS. ANALYSIS: One large CR (*e.g.* Fuji 9000) would volumetrically service the plain image needs of the Conquest Hospital. However, component failures and maintenance periods mean non-availability of images from a single CR unit for 10 or more days per year. Statistical analysis indicated that three smaller networked units were required. SOLUTION: Three Philips (Fuji) AC3 CRs are networked with data input units (USITs) and image review stations (Philips Easyvisions) through the hospital Anite FDDI network under VLAN3 switching to provide a fail-safe configuration. The configuration allows ASCII or HL7 data input from the radiology information system to the USITs to avoid excess radiographer data input. Images may be reviewed on any Easyvision station and, if required, images printed or exported to PACS. Two Easyvisions are independently networked to Imation 8500/8700 dry laser imagers to provide double back-stop protection against PACS failure. The Easyvisions also receive proprietary input from Philips DSI and DSA units. Re-export of this data is in DICOM 3.0 format. As DICOM 3.0 Service Class providers and users they can receive and send DICOM data to other networked modalities if required. The flexible configuration allows agreed high penalty clauses in the CR operating lease in the event of total non-availability of a functioning CR unit.

1200–1300
Scientific Session
MRI for Radiographers—Musculoskeletal MRI
Olympian Suite

1200
Invited Review
Optimizing sequences in the musculoskeletal system
P M Cavanagh
Diagnostic Imaging, Musgrove Park Site, Taunton TA1 5DA, UK
Although, in principle, higher field strength should result in better image production, there are many other factors in the imaging process that contribute to image quality and most of these are under the control of the radiographer. This presentation will highlight aspects of the scanning process that will affect the final image. Before considering the choice of sequence, the choice of coil and positioning of the patient will be discussed. Despite MRI's established role in musculoskeletal imaging, there is still debate as to the use of the various types of sequence (*e.g.* conventional spin echo, fast spin echo and gradient echo scanning). The advantages and disadvantages of these sequence options will be outlined. Finally, certain parameters common to all sequences, such as field of view, matrix, slice thickness and number of excitations, will also affect the final image, as well as the time of the examination. Imaging in MRI is often a compromise between optimizing image production and ensuring an adequate throughput for the scanner. With a working knowledge of all the interrelating components of image production, the radiographer can play a vital role in enhancing MRI of the musculoskeletal system.

1230
Patellar tendinitis and patellar tracking abnormalities
G M Allen, P G Tauro and S J Ostlere
Department of Radiology, Nuffield Orthopaedic Centre, Oxford OX3 7LD, UK
PURPOSE: To test the hypothesis that there is a relationship between proximal patellar tendinitis and patellar tracking abnormalities. METHOD: The reports of 960 MRI examinations of the knee in 722 patients were reviewed. All patients had routine static sequences in addition to true dynamic patellar tracking studies in the axial plane, performed from 30–40° of flexion to full extension. The static gradient echo T_2-weighted sagittal images and the dynamic tracking studies were reviewed in those cases with a diagnosis of proximal patellar tendinitis. The criteria for inclusion in the tendinitis group was the presence of high signal, similar to that of fluid, within the proximal portion of the tendon on the T_2 weighted image. On tracking studies, both lateral tilt or lateral subluxation of the patella were considered abnormal. The ratio of abnormal to normal tracking studies in the tendinitis group was compared with that in the non-tendinitis group. The possibility of an association between patellar tendinitis and abnormal tracking was tested using the χ^2 test. RESULTS: There were 44 knees with proximal patellar tendinitis, 20 of which were associated with patella tracking abnormalities. Tendinitis was related to the tip of the inferior pole of the patella in 31 cases. In 13 cases the abnormality was positioned more laterally, with apparent impingement on the anterior edge of the lateral femoral condyle. In the control group, 664 knees had normal and 252 abnormal dynamic studies. χ^2 test showed that there is an association between patellar tendinitis and patellar tracking abnormalities ($p=0.001$).

1240
Is single sequence MRI a reliable test for suspected meniscal pathology?
B Burns and S J Ostlere
Department of Radiology, Nuffield Orthopaedic Centre NHS Trust, Oxford OX3 7LD, UK
PURPOSE: To determine whether a single gradient echo T_{2*} weighted sequence is adequate for screening patients with suspected meniscal pathology. METHOD: The sagittal gradient echo T_{2*} weighted sequence (FLASH) of 88 MRI examinations of the knee in patients, without a history of menisectomy, were reviewed by an experienced musculoskeletal radiologist. All patients had arthroscopic follow-up. Examinations were performed on a Siemens 1.0 T Impact scanner. The imaging parameters were as follows: TR 600, TE 18, flip angle 30°, 2 NEX, FOV 180 × 180, matrix 256 × 256 and acquisition time 5.09 min. The state of the menisci and cruciates were documented as definitely torn, definitely normal, or equivocal. Sensitivities and specificities were calculated using the arthroscopy report as the "gold standard". In cases of disagreement, the additional sequences (FISP volume acquisition and STIR coronal) were reviewed to determine whether these would have influenced the original assessment. RESULTS: For tears of individual menisci there were a total of 117 true negatives, 42 true positives, 11 false positives and no false negatives (sensitivity 100%, specificity 91%). In the six menisci considered equivocal on MRI no tears were seen at arthroscopy. 10 of the 11 false positives involved the medial meniscus. For ACL tears MRI had a sensitivity of 78% and specificity of 98%. Review of all three sequences did not alter the original assessment in those cases where there was a discrepancy between the MRI and arthroscopy. CONCLUSION: MRI, using only a gradient-echo T_2* weighted sagittal sequence, is an effective technique for screening for meniscal tears.

1250
Dynamic real-time MRI: a new diagnostic modality for occult groin pain?
S Gould, G Lamb, N Vaughan, W Gedroyc and A Darzi
Academic Surgical Unit and Interventional MRI Unit, Imperial College of Medicine at St Mary's, London W2 1NY, UK
PURPOSE: Persistent groin pain without clinical signs is a difficult diagnostic and management problem. Some patients have occult inguinal herniae, but others have musculotendinous injuries not requiring surgery. Existing diagnostic modalities are either invasive, or insufficiently sensitive to reliably distinguish the two. This results in a high negative surgical exploration rate. Interventional MRI units (IMR) allow real-time imaging in physiological positions and during muscular exertion. The aim of this study was to develop a non-invasive dynamic IMR technique to differentiate these lesions. MATERIALS AND METHODS: 11 patients (nine male, two female; age range 29–73 years, median age 43 years) were studied in a 0.5 T General Electric Signa SP IMR. One patient had a persistent painful groin swelling 3 months after open mesh hernia repair and 10 presented with occult groin pain without physical signs (one had undergone a previous inguinal hernia repair). Static imaging [T_1 FSE, fast gradient recalled (FSPGR) and STIR] was performed supine for detailed anatomical examination and differentiation of structural from inflammatory lesions. Dynamic real time imaging (FSPGR, acquisition time 2 s) was then performed supine and kneeling at rest and during a Valsalva manoeuvre to assess inguinal canal integrity with muscular exertion in a physiological position. RESULTS: All patients tolerated the procedure. Of the 10 patients without physical signs, imaging revealed one indirect sac (male, 30 years) and one recurrent direct sac (male, 60 years). Defects in the fascia transversalis were clearly delineated and the sacs could be seen herniating through these defects on Valsalva manoeuvre. STIR images in these cases were normal. Seven others demonstrated high signal on STIR images in the posterior rectus muscle, conjoint tendon or at the pubic insertion of the inguinal ligament. No hernial defect was demonstrated in these cases. These findings were consistent with musculotendinous injury. No abnormality was demonstrated in the final case with occult groin pain (male, 24 years). The lesion in the patient with persistent groin pain and swelling after previous repair was demonstrated to be a cord haematoma and not a recurrent hernia by high signal on T_2 and STIR imaging. CONCLUSION: This study has demonstrated that dynamic MRI in physiological positions can detect and differentiate occult groin herniae from musculotendinous injuries. This may reduce the high negative surgical exploration rate for such patients in future.

1230–1330
Scientific Session
Paediatric Imaging
Hall 10a

1230
The value of CEC image criteria in neonatal radiography
R Chaudhuri, A Lowe, J Shekdar, D Boniface and A Finch
Faculty of Radiography, University of Hertfordshire, Hatfield AL10 9AB and Department of Diagnostic Radiology, The Hillingdon Hospital, Uxbridge, Middlesex UB8 3NN, UK
PURPOSE: As part of an MRC/North Thames funded study in neonatal chest radiography, guidelines in the CEC document *Quality criteria for diagnostic radiographic images* were developed

and used to correlate image quality, dose to patient and interreader and intrareader reliability. The criteria used in this study will be discussed. MATERIALS AND METHODS: Only the CEC image criteria specifically relating to exposure were examined by a radiologist, radiographer and medical physicist. A shortfall was noted with regard to films of high optical density and another criterion was developed to negate over-marking of such films. A scoring system was devised and eight baseline neonatal chest radiographs (CXRs) were rated by six paediatric radiologists, five based at each of the participating hospitals and the sixth being the common second reader. 20–40 consecutive neo-natal unit CXRs were then scored by each site's internal reader. The sixth reader marked all the images from all sites. Four films from the baseline set were re-inserted into each batch to check interreader and intrareader reliability. RESULTS: Intrareader reliability was consistent. Interreader reliability was also consistent in five out of six cases, one reader being out of step with the others for both the baseline and main study sets. The presence of lung pathology often impeded accurate assessment of image quality criteria. CONCLUSION: The CEC image criteria provide useful guidelines and are consistent for individual readers, but may not be so between some readers. Exclusion of assessment of pulmonary vasculature and mediastinal outline, and addition of diagnostic value to the criteria, would obviate the problems encountered in the presence of pathology.

1240

Dose reduction in paediatric high resolution CT of the chest

M Easty, C Dicks-Mireaux, K McHugh and C Young
Great Ormond Street Hospital, Department of Radiology, London WC1N 3JH, UK

PURPOSE: To compare the diagnostic quality of high resolution CT (HRCT) images of the lungs obtained at 90 mA and 50 mA with a view to paediatric HRCT of the chest. METHODS: 20 patients with differing lung pathologies underwent HRCT of the chest. 10 male, 10 female with an age range of 4 months to 21 years and 2 months. HRCT was performed with alternate slices at 90 mA and 50 mA using a Siemens Somatom Plus 4 CT scanner. Slice thickness was 2 mm with a 0.75 s scan time and a 10 mm table increment. All scans were performed at 120 kVp. All scan images were reviewed independently by two consultant paediatric radiologists, blinded to the image details. Each image was assessed to see whether they were normal, not evaluable, showed ground glass haziness, consolidation, reticulo-nodular pattern, cysts, bronchiectasis, air trapping, nodules, graininess and artefacts. Dosimetry was performed. RESULTS: The slice details were reviewed and statistics performed on the differences in findings between the two consultants. Graininess and artefacts were found in the top four slices in the majority of cases. All the non-evaluable scans involved the top two or bottom two slices. CONCLUSIONS: Current can be reduced to 50 mA in paediatric HRCT without loss of useful information, giving a significant dose reduction. As the top and bottom slices are prone to artefacts, HRCT could be performed from the arch to the mid-left atrium in the majority of patients with diffuse lung disease. In older children, larger table increments could be used, thereby reducing the dose.

1250

Patterns of referral for radiographs from neonatal units; a retrospective survey

R Chaudhuri, A Lowe, J Shekdar, D Boniface and A Finch
Faculty of Radiography, University of Hertfordshire, Hatfield AL10 9AB and Department of Diagnostic Radiology, The Hillingdon Hospital, Uxbridge, Middlesex UB8 3NN, UK

PURPOSE: As part of an MRC/North Thames funded project on neonatal radiography, a retrospective survey of radiographs taken on neonatal units was performed at five sites. MATERIALS AND METHODS: Data on request forms made in a specified 2 month period were gathered. The number of missing request forms, frequency of patients requiring radiographs, indications for each radiograph and the nature of the study were documented. RESULTS: Over 1000 requests were made for 197 babies. Two sites out of the five studied routinely destroy request forms after 3 months and do not routinely report neonatal radiographs. Neonates needing more than 10 radiographs were critically ill, or long-stay patients. These were 14% of subjects, but theirs accounted for 57% of requests. At four sites, 22–54% of request forms were missing, only 0.5% being lost at the other site. 72–90% of requests were for chest radiographs. The highest percentage of requests was for "deterioration in cardio-respiratory status" (25–40%) and for checking the position of lines and tubes (20–30%). Inadequate clinical information, or no indication, was given in 2.5–17% of cases. CONCLUSION: Similar requesting patterns were discerned between the five units. The illest babies had more X-rays and the commonest requests were for films which might change clinical management. Of concern is the high number of inappropriate request forms, $\leqslant$17%, which may have medico legal and radiation dose implications, and suggest guidelines for radiographers and paediatricians are necessary, especially for out-of-hours, mobile radiography. The medico–legal implications of destroying or losing request forms and of not reporting films also need to be considered.

1300

Air-augmented abdominal X-ray in neonatal high gastrointestinal obstructions

R L Harrison, P Set and A L J Brain
Departments of Radiology and Surgery, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK

INTRODUCTION: Air is a safe and effective natural contrast agent in high neonatal gastrointestinal (GIT) obstruction. However, successful early resuscitation often results in plain abdominal radiographs of low diagnostic yield. We present a series of 14 neonates with high GIT obstruction in whom air-augmented abdominal radiographs (AAR) were performed instead. METHODS AND MATERIALS: Over a 2 year period, 14 neonates with acute high GIT obstruction had AAR following resuscitation. A 6F feeding tube was inserted and a measured volume of gastric contents aspirated. The exact same volume of air was slowly introduced and an immediate abdominal X-ray taken on the neonatal intensive care unit. RESULTS: 12 sick babies had their obstruction confirmed and the respective levels sited. The other two older neonates required further positive contrast upper GIT studies, which confirmed small bowel malrotation. Both presented with less severe and subacute symptoms. CONCLUSION: In neonatal high GIT obstructions AAR provide a rapid and accurate diagnosis, reserving positive contrast upper GIT studies for cases where the diagnosis has not been confirmed.

1310

US-guided cutting needle biopsy of head and neck masses in children

G A Bain, P W P Bearcroft, L H Berman and J Grant
Department of Radiology, Addenbrooke's Hospital and the University of Cambridge, Cambridge CB2 2QQ, UK

PURPOSE: Neck masses are common in children. Lymph nodes, thyroid or salivary glands or brachial arch remnants are common sites of origin, although significant pathology is rare and there is a high incidence of benign lymphadenopathy. Nevertheless, biopsy is frequently required for definitive diagnosis. Tissue is conveniently obtained by open biopsy or by fine needle aspiration cytology. Histology is more accurate than cytology, but requires general anaesthesia. Histological sampling using US-guided core biopsy has not previously been described in children. We present our experience of performing cutting needle biopsies of neck lumps in children under local anaesthesia only. METHODS: 15 children were referred for biopsy (range 3 months to 16 years, mean 9 years 7 months). These were performed using topical and injected local anaesthetic. A non-advancing, spring-loaded disposable cutting biopsy needle was used with free hand US guidance. RESULTS: No sedation was required in 13 of the 15 cases. In all cases adequate tissue was successfully recovered. In only two of six who underwent subsequent open biopsies was further diagnostic information provided. CONCLUSION: US-guided cutting needle neck biopsy is a safe procedure which can usually be performed successfully in unsedated children. It frequently obviates the need for surgery.

1320

Utilization of gonad protection for female paediatric patients with developmental dysplasia of the hip

C M Ferris and C M Thompson
Division of Professions Allied to Medicine—Radiography, Sheffield Hallam University, Sheffield S10 2BP, UK

PURPOSE: An investigation into the appropriate use of gonad shields on female paediatric patients undergoing treatment and monitoring for previously diagnosed developmental dysplasia of the hip. METHOD: A study and analysis of films taken during a 12 month period on female patients of a maximum of 12 months of age at the time of examination in three district general hospitals. Sample size is 17 patients and 71 radiographs. Quantitative data is collected using categorization of gonad protection used into presence, shape, size and ovarian shielding. Qualitative data is collected to identify aims of, and influences on practice through semi-structured interview of 20 radiographers. RESULTS: Gonad shields are omitted in 48% of radiographs, gonad shields present, but with

inadequate coverage of ovaries, in 43.6%; gonad shields present and adequately covering ovaries 8.4% radiographs. Radiographers identify a combination of immobilization difficulties, combined with the effects of motoric distress as the greatest influence on the use of gonad shields. Incidental findings show 13 radiographs missing from film packets and 15 extra examinations conducted, but not entered into the departmental database. CONCLUSIONS: This study demonstrates that gonad protection shields could be better utilized to prevent avoidable gonad irradiation for female patients with developmental dysplasia of the hip. In addition, the incidental findings should be further researched.

1300–1345
British Institute of Radiology
Silvanus Thompson Memorial Lecture
Hall 1

1300
Eponymous Lecture
Computer assisted navigation and augmented reality in image guided interventions
D J Hawkes, P J Edwards, D A DeCunha and D L G Hill
Radiological Sciences, UMDS, Guy's Hospital, London SE1 9RT, UK
Recent advances in computer graphics, image processing and virtual reality techniques are being brought together to provide assistance to the surgeon in complex operations or in minimally invasive interventions. In our laboratory we are developing a system to provide augmented reality in procedures of the skull base. 3D computer models of relevant anatomy and pathology are constructed from MR and CT images and projected as an accurately aligned overlay into the binocular optics of the stereo operating microscope. The process of accurate calibration, accounting for variable focus and zoom of the microscope, is described. Correct positioning of these virtual objects in the stereo scene requires very accurate registration of the pre-operative image models with the patient. Alternative means by which this may be achieved will be presented and their relative performance evaluated. The display of the virtual stereo scene, in order to give the correct perception of 3D location in the "real world" view of the surgical scene, is difficult. Careful attention has to be paid to the full range of 3D depth cues. Issues arising from the study of these "human factors" will be described. Once an augmented reality scene giving the correct perception of depth is created this provides opportunities for more realistic surgical training systems and surgical planning tools. This also creates an opportunity to develop telepresence in surgery whereby the surgeon is separated from the operation either by distance (in telesurgery) or scale (in microsurgery).

1315–1345
Keynote Lecture
Integrated Workforce Planning
Hall 9

1315
Invited Review
Integrated workforce planning
C S F Easmon
North Thames Regional Office, London W2 3QR, UK
Work-force planning in the NHS is traditionally done by a professional group. The system for radiologists is the medical one; speciality driven and predominantly national and top-down, with specialist registrar quotas decided by the Speciality Workforce Advisory Group. For radiographers, the system is increasingly employer-led and bottom-up, with far greater local NHS input. There is little link between these systems. An integrated approach to work-force planning would start with considering the range of skills needed to provide a local service and the pattern of staffing and professional skill mix needed to sustain this. Integrated work force planning does not mean the introduction of a generic worker, or disparaging the importance of professional values and standards. The challenge is to bring together the currently very different systems and to balance professional and NHS needs.

1330–1400
Keynote Lecture
Dental and Maxillofacial Radiography
Olympian Suite

1330
Invited Review
Current developments in dental and maxillofacial radiography
S M Bourne
St Bartholomew's and The Royal London Hospital School of Medicine and Dentistry, London E1, UK
This lecture updates delegates on the current trends in dental and maxillofacial radiography. These developments include: the use of film holders in intraoral techniques, to standardize and reproduce images; digitizing of images, both intraorally and extraorally, so that images can be achieved with a lower dose; the use of specialized tomographic equipment and CT scanning to obtain accurate information of the patient's anatomy of the maxilla and mandible for dental implants; CT scanning for imaging head and neck pathology; and the use of MRI, US and radioisotope scanning.

1400–1445
Keynote Lecture
Interventional Radiology
Hall 1

1400
Invited Review
Arterial stents
P A Gaines
Sheffield Vascular Institute, Northern General Hospital, Sheffield S5 7AU, UK
Dotter was a genius. In his original paper describing the percutaneous dilatation of peripheral arterial disease, he recognized the potential limitations of the procedure and suggested that some form of internal support may be helpful. He and others pursued this concept of vascular stents, resulting in the current stent revolution. Simple, uncovered stents are now used throughout the arterial tree, most commonly in the coronary and aortoiliac systems, but also for renal, upper limb and carotid disease. Covered stents are coming of age and are being applied to aneurysms, arteriovenous fistulae, and extensive occlusive disease. This review will review the data on the common (aortoiliac), exciting (abdominal aortic aneurysms) and extreme (carotids) and asks: do they have significant clinical benefit over conventional treatment (surgery or simple balloon angioplasty)? How can we justify their expense? Where do we go next?

1400–1600
College of Radiographers
Students' Scientific Session
Hall 9

Please see p. 133 for abstracts.

1400–1520
Debate
This House Believes Predictive Assays Have a Role to Play in Radiotherapy
Hall 10b

1400
The case for radiosensitivity
J Peacock
Institute for Cancer Research, Sutton, Surrey, UK

1420
The case against radiosensitivity
S Bentzen
Gray Laboratory Cancer Research Trust, Northwood, Middlesex, UK

1440
The case for proliferation
G D Wilson
Gray Laboratory Cancer Research Trust, Northwood, Middlesex, UK

1500
The case against proliferation
G G Steel
The Institute of Cancer Research, Sutton, Surrey, UK

This debate will focus on attempts that are being made on the basis of laboratory studies to predict the response to radiation of tumours and normal tissues, and thus to improve the management of patients with cancer. Participants will deal with two current areas of investigation: prediction based on the measurement of radiosensitivity in tumour and normal-tissue cells, and prediction based on studies of the proliferation rate of tumour cells. It will be assumed that the audience is familiar with the scientific basis of these approaches. Speakers will consider the evidence for interpatient differences in the measured parameters, debating whether these differences are large enough to be reliably detected and to allow useful clinical response. The current clinical evidence for therapeutic gain by these approaches will be considered.

TUESDAY

1400–1530
State of the Art Symposium
Computer Based Multimedia in Healthcare: The Salford Experience—*in association with CAR*
Hall 11a

1400
Invited Review
GEMISIS 2000: Information and communication technologies and tomorrow's healthcare
J Powell
The Graduate School, Salford University, Salford, UK

This paper will describe an attempt in the Salford, Greater Manchester area of the UK, through the GEMISIS 2000 project, to understand how interactive broadband technologies, commonly known as the "information superhighway", can be utilized for the economic and social good of a whole community. It provides a context to support a series of papers from Salford University's pioneering developments of user-centred and user-valuable convergent media support for healthcare. At the most general level, GEMISIS 2000, a £12 million programme of work, with an acronym standing for the exploitation by government, education, medicine, industry and society of the information superhighway, is a true partnership between the University of Salford, the City of Salford, the Manchester Training Enterprise Council, the Manchester Chamber of Commerce, Hope Hospital, Cable and Wireless, ICL and Newbridge. GEMISIS 2000 not only uses leading edge information technology, but is primarily community-based and needs-centred; is user-driven and services-oriented; and is formed by a partnership of totally committed, public and private organizations each having complementary roles, in establishing the information superhighway in the Northwest of England. The partnership looks to employ broadband technologies to deal with many different things: decentralizing systems of employment, so that urban areas are not over-burdened; generating the growth of new information and communication-based industries, as well as promoting the "re-engineering" of existing industries; radically improving the quality and efficiency of public services; improving the quality of life by enhancing performance in such fields as medical care, education, government administration, transportation; addressing environmental concerns, by partially replacing the movement of people and goods with the flow of information, and reducing the generation of CO_2 and other pollutants; helping the elderly and others who are disenfranchised participate in society and, with respect to the present audience, ensuring that they receive adequate medical and health care. GEMISIS 2000 uses the skills of 30 doctoral students and their faculty supervisors to explore in depth the issues involved in applying these technologies, as well as the barriers to such applications. It is now clear that broadband cable networking, asynchronous transfer mode (ATM) technology, high quality/capacity media storage/servers and interface hardware are sufficiently advanced and robust to be of significant value to society. The biggest barriers to beneficial change are no longer technical, they are human, resistances which operate at the individual, social and cultural levels. GEMISIS is trying to create, within itself and beyond, an open environment to systemically and holistically understand the issues and problems of creating the information society. Working closely with healthcare professionals, Salford's Convergent Media Developments Team have produced a portfolio of working tools to help local primary and secondary healthcare. They have placed much emphasis on designing, implementing and evaluating materials, interfaces to users and necessary support, which informs and aids decision making. In this respect their approach reflects current understandings of the different ways people learn and could be helped to learn more effectively. In particular, the present author has shown how a four-fold model of learning can be used to improve remote communication and aid the transfer of understanding between multiprofessional groups. The conference presentation will attempt to demonstrate this, in the context of a discussion and knowledge transfer between a radiologist and radiographer, using audiovisual vignettes which make the new convergent media technologies so powerful, yet accessible.

1415
Invited Review
Computer-based multimedia information systems for patients, partners and members of the public
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Computer-based approaches can be used to provide healthcare information. We have created several computer-based prototypes to help provide information to our patients and members of the public. Examples include *Choices in your Childbirth*, *Diabetes Information for Sufferers* and *Coronary Heart Disease Prevention*. Our aim is to develop and evaluate the prototypes as they would be used in accessible public areas, such as libraries, GP practices, community centres and hospitals. The "Booking Scan Information System for Obstetric Ultrasound" is a major section within the *Choices in your Childbirth* prototype. This prototype has been in routine clinical use for over 6 months and significant data have been generated about its use and perceived value. The analytical data were a combination of on-line ($n > 1000$) and analogue questionnaires ($n = 115$), interviews ($n = 10$) and observations. The analysis showed encouraging results. Key findings indicate that the prototype was used and liked, and was considered to be a valuable source of information. Some people did not like computerized information systems and in all cases human contact was considered essential. In the US department, various factors need to be optimized for effective use. These include having two headphones sets

accessible for simultaneous participation of both the patient and partner; an auto-run option must be provided; as must a first-page, automatic-reset facility. The computer must be placed in an "inviting" environment. This presentation will explore in detail the development and analysis of the US prototype and includes a demonstration.

1435
Invited Review
The development and evaluation of multimedia health education materials
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This paper describes methods and issues that need to be addressed in the development of multimedia health education materials. Developments in communications and learning technologies are offering attractive possibilities for health education. There are increasing opportunities for dissemination of information—the World Wide Web has many health sites. The availability of on-line information regarding health and health promotion is growing each year. There is even evidence of virtual communities on the Web. The technology is not intended to replace, but rather to enhance personal interaction between providers and patients. However, there is a danger of lack of overall quality assurance and dissemination. Changes in technological provision will improve access, but it will not solve the problem of how to motivate individuals and groups to use and learn from health education materials. Health education materials have the potential to influence health behaviour. However, the realization of this potential lies in the extent to which theory and knowledge are translated into intervention that interest and influence the target population. Multimedia educational computing is a relatively new concept and one with which people are still experimenting. Early research and development focused on more efficient and effective access to information, which was generally structured using a paper-based metaphor (books, pages, chapters). They therefore promote similar educational strategies to textbooks, such as rote learning. Studies have shown that the most effective software packages actively engage learners. A constructivist theory of learning suggests that "learning by doing" is highly effective. Multimedia has the potential to provide patients with individualized information which can help motivate them to change their behaviour.

1455
Invited Review
Computer-based information and education systems for health care workers
[1]P Hogg, [2]D Farnworth, [2]C Hennessy, [2]L Williams, [2]J Dodgeon, [2]J Hindle and [2]P Rowland
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Computer-based approaches can be used to provide health care students and professionals with information about their domain. Such computer-mediated approaches have been shown to have value in pre-registration education and training and subsequent continuing professional development (CPD). Computer-based approaches also have value in the support of decisions made in the clinical setting. Work within the University of Salford and in collaboration with Salford Royal Hospitals NHS Trust has resulted in the development and analysis of several software prototypes which aspire to meet the above needs. To highlight the possibilities, this review will focus on two examples: (i) a computer based learning (CAL) prototype for undergraduate radiographers, this is based on a guided discovery paradigm; (ii) an information and CPD prototype for obstetric US, this is intended for use in the clinical setting. Both prototypes were created and assessed using the dynamic systems development method, a user-centred approach. Each prototype makes extensive use of multimedia (including digital video, sound and pictures). User self-assessment is built into each prototype. The undergraduate CAL prototype was assessed against two control conditions and was found to be an effective and acceptable method of learning, demonstrating a significant baseline to post-session knowledge increase ($p<0.0001$). The information/CPD prototype was assessed by practising midwives and was found to be an effective way of keeping staff up-to-date. The method was acceptable and effective, and volunteers demonstrated a significant baseline to post-session knowledge increase ($p=0.01$). Both prototypes will be demonstrated in this review.

1515
Discussion

1400–1450
Scientific Session
MRI Vessels
Hall 11b

1400
Assessment of Gd-BOPTA for magnetic resonance angiography: results of a Phase I study
[1]M V Knopp, [1]S Schoenberg, [1]C Rehm, [1]M Bock, [1]M Essig, [2]R Hentrich and [1]G van Kaick
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PURPOSE: To evaluate MultiHance (Gd-BOPTA/Dimeg) as a contrast agent for magnetic resonance angiography (MRA). MATERIALS AND METHODS: MultiHance is a weakly protein-binding gadolinium chelate, which shows improved enhancement characteristics in animal studies over currently used gadolinium chelates, which do not bind to proteins. An initial Phase I study was performed to assess the impact of different doses and infusion rates for contrast-enhanced MRA ($n=10$). Thereafter, a study to compare the efficacy of MultiHance and gadopentetate dimeglumine (Gd-DTPA) for contrast-enhanced MRA of the abdominal aorta was performed as a randomized, double blind, intraindividual cross-over comparison ($n=10$). The studies were performed on a 1.5 T MRI system (Magnetom VISION, Siemens, Iselin, NJ) using the standard phased array body coil. A fast gradient echo angio-sequence was modified to enable the sequential acquisition of image s^{-1} in a coronal slab with 128 repetitions. Quantitative assessment of vascular enhancement was carried out by region-of-interest (ROI) analysis of S/So. The time–signal curves obtained were analysed in terms of intensity and duration of peak enhancement. RESULTS: The initial Phase I study revealed that increased peak signal intensities were obtained when faster flow rates and higher doses were used. The intraindividual comparison of MultiHance and Gd-DTPA showed that MultiHance produced higher signal intensities for peak vascular enhancement and late vascular enhancement. Furthermore, the duration of the mean peak vascular enhancement was longer and the area under the mean cumulative enhancement curve larger for MultiHance. CONCLUSIONS: MultiHance showed improved vascular enhancement characteristics with higher signal intensity and longer duration of intravascular peak enhancement compared with gadopentetate dimeglumine in MRA of the abdominal aorta. The findings suggest that MultiHance may further improve vascular MRA.

1410
MRI following aortic root replacement surgery
M J Thornton, B Kenny and K P Murphy
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PURPOSE: To assess the use of MRI in the follow-up of patients 6 and 18 months after aortic root replacement surgery. METHOD: All patients who have undergone either elective or emergency aortic root replacement surgery at Bristol Royal Infirmary since 1992 were considered for entry into the study. The type of imaging performed prior to surgery was not an exclusion criterion, but many of the patients had been assessed with MRI before surgery. Patients were excluded from the study if they were unsuitable for MRI scanning, or lived too far away. RESULTS: Between 1992 and 1996, 48 patients have undergone aortic root replacement in our institution. 26 patients were included in the study. 19 have had one follow-up scan, six have had two follow-up scans, and one has had five follow-up scans. In the study group, surgery was performed for aortic dissection (14), aortic aneurysm (11) and aortic false aneurysm (one). Four patients had Marfan's syndrome. Review of MRI scans demonstrates excellent anatomical definition using T_1 weighted spin echo sequences. In all patients important findings were demonstrated which were not apparent on chest radiographs; these included the extent of residual dissection and the size of aneurysms of the more distal aorta. In the patient who had five scans, the second scan revealed a false aneurysm that required revision surgery. CONCLUSION: MRI offers an excellent method of imaging aortic root replacement.

1420

Dynamic, breath-hold 3D gadolinium-enhanced magnetic resonance angiography of the thoracic aorta and great vessels

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PURPOSE: We describe the technique of dynamic breath-hold 3D gadolinium-enhanced magnetic resonance angiography (MRA) for the evaluation of the thoracic aorta and great vessels. MATERIALS AND METHODS: 18 patients underwent thoracic MRI examinations, including dynamic breath-hold 3D gadolinium-enhanced MRA. All examinations were performed with a 1.5 T Siemen's Vision MRI scanner, which has an increased gradient specification (25 m T/m). A 23 s breath-hold FISP gradient echo sequence was used during a bolus injection of 0.2 mmol kg^{-1} gadodiamide (GdDTPA-BMA). Bolus was timed to pass during central κ space. Three consecutive measurements were obtained to ensure acquisition of the bolus with a 5–10 s pause between measurements. Two readers evaluated the images. RESULTS: 18 patients were scanned. Findings included: aneurysmal dilatation ($n=4$), dissection ($n=2$), previous dissection repair ($n=3$), coarctation ($n=1$), previous coarctation repair ($n=2$), partial anomalous pulmonary venous drainage ($n=1$), pulmonary homograft conduit stenosis ($n=1$), occluded subclavian ($n=1$) and normal ($n=3$). There were no complications related to the examination. Good contrast enhancement were obtained in 17 of the 18 patients. In a single patient suboptimal contrast enhancement was thought to be due to injection in the hand, the antecubital fossa was normally used. CONCLUSION: Dynamic, breath-hold 3D gadolinium-enhanced MRA is a safe and reliable technique in investigation of disease in the thoracic aorta and great vessels. Injection timing should be varied, depending on cardiac output and underlying pathology. Consecutive breath-hold scans also help to ensure acquisition of the peak contrast concentration during the middle of κ space.

1430

Optimization of contrast-enhanced magnetic resonance angiography of the iliac arteries by injection simulation

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PURPOSE: To use computer simulation of the contrast agent concentration following injection to optimize contrast-enhanced magnetic resonance angiography (CE-MRA) examination of the iliac arteries. METHODS: 12 patients with stenosis over 50% (diagnosed by DSA) had CE-MRA examinations, with a dose of either 0.3 or 0.5 mmol kg^{-1} body weight. Gadodiamide (Omniscan, Nycomed) assigned at random. Initially, a fast injection of 10% of the allocated dose (timing bolus) was used to assess the delay between the injection and delivery of contrast agent to the iliac arteries. The delay to peak enhancement was calculated from a series of consecutive images of the abdominal aorta. The main injection was subsequently synchronized with the CE-MRA pulse sequence (short echo time 3D gradient echo). The image intensity over the abdominal aorta was used to produce an estimated impulse response function (IRF) of contrast agent concentration as a function of time following the timing bolus injection. The IRF was used to model injections of different duration and different data acquisition schemes (centric and sequential κ space coverage). RESULTS: Peak contrast agent concentration is not inversely proportional to the total injection time, with longer injections achieving better enhancement than expected due to recirculation. With long injections, a sequential κ space coverage should produce the best results and make the technique relatively insensitive to timing errors. Overall, the iliac CE-MRA examinations obtained with this technique are encouraging. CONCLUSION: Simulations showed that CE-MRA of the iliac arteries with long contrast agent injection is an effective and robust technique, primarily due to recirculation effects.

1440

Stepping-table gadolinium-enhanced digital subtraction magnetic resonance angiography of the aorta and lower extremity arteries

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PURPOSE: Contrast-enhanced magnetic resonance angiography (MRA) of the peripheral vasculature is limited by the small field-of-view available with MRI scanners (45 cm) relative to the large anatomical region-of-interest (>100 cm). We overcame this limitation by moving the table between three consecutive overlapping coronal acquisitions centred over the aorta–iliac, femero-popliteal, and below-knee segments. MATERIALS AND METHODS: 20 patients underwent both conventional catheter angiography and gadolinium-enhanced MRA at 1.5 T of the aorta and outflow vessels, acquired in three consecutive imaging stations during a single infusion of a gadolinium chelate. RESULTS: Compared with catheter arteriography, MRA had 95% sensitivity and 98% specificity for demonstration of occlusions, but MRA confirmed patency of numerous segments thought to be occluded on DSA. There was good interobserver correlation between the two readers overall, weighted κ 0.834 for all lesions, κ 0.861 for reporting of insignificant (<50%) stenoses, compared with significant (>50%) ones; and κ 0.917 for reporting of occluded *vs* patent (0–99% stenosis) segments. CONCLUSION: Stepping table, digital subtraction contrast-enhanced MRA shows high accuracy compared with catheter arteriography in patients with arterio-occlusive disease of the aorta and outflow vessels. Our preliminary results suggest that this technique may ultimately provide a safe, non-invasive and cost-effective alternative to catheter arteriography.

1415–1555
State of the Art Symposium
Digital Imaging—*in association with CAR*
Hall 10a

1415

Invited Review

Co-registration and analysis of multimodality imaging

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Co-registration of multimodality images is finding application in many areas of diagnostic radiology and image-guided interventions. The purpose of image registration is to establish correspondence between features visible in different images. An ideal algorithm for image registration should be automatic, accurate and robust. The validation of an algorithm based on normalized mutual information is described. Accurate and robust fully automated rigid body alignment of MR, CT and PET images of the head is now possible provided more than 40 mm of overlapping axial extent of the image volumes is available. We have defined a metric of registration as the mean displacement averaged over the imaged volume. Compared with "gold standard" registration provided by bone screws, MR CT registration is accurate to 1.3 mm and MR PET registration is accurate to 2.8 mm. Simple modifications of the algorithm, but using the same paradigm, allow registration of images that are erroneously scaled or skewed, for example, from CT gantry tilt. Recent work has shown that the algorithm can also be extended to register images of deforming structures, such as MR images of the breast, or to establish the pose of projection images, such as fluoroscopy or video images, with volume images. The latter is finding application in image-guided interventions.

1445

How low can you go? Noise and exposure in computed radiography

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Computed radiography (CR) has a very wide (linear) exposure latitude and can reduce population doses by decreasing the number of repeats needed. It is arguable whether it can significantly reduce individual patient doses by reducing the radiographic factors of the examination, compared with conventional film/screens. At low exposures, information is obscured by quantum noise and, generally, on clinical systems, post-processing cannot retrieve it. This study assesses the level of exposure at which diagnostic information in chest images begins to be "lost" to noise for the Kodak CR400 system installed at Whiston Hospital in Merseyside. A series of images of an anthropomorphic chest phantom were obtained with progressively less exposure and viewed by a radiologist. Those images identified as being non-diagnostic were sent to an independent work-station, where noise reduction procedures were used in an effort to retrieve diagnostic information. These images

were reviewed. A threshold contrast, detail-detectability test object was also used. Dose reduction may benefit from noise reduction techniques for low exposure CR images. This may be useful for dose sensitive groups, *e.g.* paediatrics. We are also investigating the use of enhancement techniques for low exposure images obtained by digitizing films from very wide latitude film/screen systems. However, fine detail may be lost during noise reduction and the process may not be appropriate for pathologies whose diagnosis depends upon this fine detail.

1455

Noise estimation in digital X-ray imaging

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PURPOSE: A fast and easy algorithm has been developed to estimate noise in single digital images. Knowledge of this noise is essential for optimization of imaging systems, including dose reduction strategies. METHOD: The noise has been estimated using two median filtered images and the original image. Highly structured regions of the image are rejected to avoid spurious noise estimates. The method has been applied to digital angiographic images of various phantoms, including an anthropomorphic chest phantom. The algorithm has been validated by comparing with "true" noise estimates from a series of repeat images taken for each phantom. RESULTS: Both estimates of noise agree well over the entire grey level range (0–1023). The difference between the estimates is 0–3 grey levels, depending on pixel value. CONCLUSION: The median filter method provides a good estimate of the "real" image noise. The algorithm is fast and can be applied to a single image.

1505

Technical measurements of an experimental clinical flat panel dynamic digital X-ray detector

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PURPOSE: To establish the technical feasibility of an experimental flat panel dynamic X-ray detector (known generically as FDXD-Philips Medical Systems, the Netherlands) system for radiological imaging operating in a universal radiography and fluoroscopy environment. METHODS AND MATERIALS: A clinical FDXD demonstrator has been developed and implemented for clinical and technical feasibility investigations. The demonstrator comprises a 20 × 20 cm detector, operating in conjunction with a pulsed grid X-ray source and a floating top radiographic table. The system provides digital fluoroscopy and high quality (high SNR) spot image acquisition for primary diagnosis in a variety of universal radiography and fluoroscopy contrast media aided examinations. The clinical demonstrator system is placed in a clinical room at a major hospital. RESULTS: We have assessed the physical image quality of the system through measurements of the modulation transfer function, noise power density (Wiener) spectra and detective quantum efficiency under different conditions. Residual technical difficulties are being identified and corrected *in situ*. Technical results are reviewed. (Clinical results are published separately.) CONCLUSION: The technical potential of the clinical FDXD prototype is established and we are working with experienced radiologists and radiographers to maximize the clinical performance of this versatile technology.

1515

Clinical experiences with an experimental flat-panel dynamic digital X-ray detector

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PURPOSE: To establish the clinical and technical use of an experimental flat-panel dynamic X-ray detector (known generically as FDXD-Philips Medical Systems, The Netherlands) system for radiological imaging, operating in a universal radiography and fluoroscopy environment. MATERIALS AND METHODS: The clinical demonstrator comprises a 20 × 20 cm detector placed under a floating top radiographic table. This operates in conjunction with a pulsed grid X-ray source and provides digital fluoroscopy (continuous and pulsed up to 25 frames per second) and high quality (high SNR) spot image acquisition for primary diagnosis in a variety of universal radiography and fluoroscopy contrast-medium aided examinations. Digital image enhancement has been achieved off-line in an imaging research facility. Clinical images are printed using a dry digital printer. The clinical demonstrator system is placed in a clinical room at a major hospital. RESULTS: The clinical use of the demonstrator is establishing the diagnostic acceptability of image quality in fluoroscopic and spot acquisition modes. The wider clinical and ergonomic potential of this versatile image acquisition modality are being explored. Technical difficulties are identified and solutions applied. CONCLUSION: These early investigations with FDXD are establishing the clinical potential and versatility of the technology, which will have a significant impact on universal radiography and fluoroscopy imaging in the future.

1525

Imaging performance of a new direct digital radiographic detector

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PURPOSE: To report the imaging performance of a new direct digital radiographic detector. MATERIALS AND METHODS: A flat-panel X-ray detector system, manufactured by Sterling Diagnostic Imaging, was used to acquire digital image data for several physical measurements. Exposures were carried out at 70 kVp with 0.5 mm Cu beam filtration. Measurements included: characteristic response, presampling-MTF and Wiener spectrum. For comparison, identical measurements were carried out using a Fuji AC3 computed radiography system using the latest generation, ST-VN, image plates. From these measurements noise equivalent quanta (NEQ) and detective quantum efficiency (DQE) spectral descriptors of system performance were derived. RESULTS: Results suggest the flat-panel detector will prove to be a viable X-ray acquisition device, suited to modern, fully-digital radiology departments. CONCLUSION: While physical measurements indicate the feasibility of the direct digital X-ray detector, the results of comprehensive clinical trials are awaited with interest.

1535

Photostimulable phosphor computed radiography *vs* digital projection radiography

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The application of photostimulable phosphor radiography (PPCR) is quickly becoming an acceptable imaging technology for many conventional radiographic procedures. The advantages and disadvantages of PPCR in a variety of clinical and operational settings has been discussed in many articles and journals. A full field direct projection radiography detector has been developed, which has the potential of offering cost-effective integration of direct projection radiographs into existing radiographic equipment. This technology could offer imaging departments many advantages and revolutionize the way in which radiology services are delivered in future. This paper will review the first experiences of digital projection radiography (DPR), technology (Sterling Diagnostic Imaging) at The Royal Victoria Infirmary in Newcastle. The presentation will outline our experiences specifically related to the operation of the unit and its future potential. We will present the results of a comparative study of computed radiography (CR) *vs* DPR chest radiography. BACKGROUND: The Royal Victoria Infirmary and Associated Hospitals NHS Trust took delivery of a CR system in October 1996. The initial clinical focus for this unit was its application in the radiography of special-care babies. However, the usefulness of this technique in all areas of conventional radiography was quickly realized and its use was expanded to general radiographic techniques, including chest radiography. The department had agreed to conduct the first European evaluation of DPR following the initial clinical trials in the USA. The Royal Victoria Infirmary has, therefore, found itself in the unique position of having a CR and DPR unit available in the department, allowing us to compare these two new imaging techniques directly.

1545

The optimization of radiographic technique in digital chest radiology

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[1]*FAXiL, Medical Physics and* [2]*Department of Radiology, The General Infirmary, Leeds LS1 3EX, UK*

PURPOSE: In recent years the radiation protection community has placed a great deal of emphasis on the setting of "dose reference values". The principal aim of these values is to identify radiology

departments using poor radiographic techniques. The values do not attempt to optimize the cost–benefit balance between image quality and dose. Digital technologies, which are now replacing screen–film systems, may be characterized by having very wide sensitometric ranges. This dynamic range allows the user a high degree of freedom when selecting the radiographic factors, the task of optimization is made harder since apparently acceptable images are produced regardless of the settings. METHODS: A digital chest radiograph system has been installed in Leeds General Infirmary for the last 2 years (upgraded in 1997) as part of an evaluation for the Medical Devices Agency of the Department of Health. As part of the evaluation, steps have been taken to determine the optimum factors for chest imaging. Measurements made include objective physical parameters (signal to noise ratio and dose) and subjective (test objects and real clinical images) measures of image quality. The factors investigated include kVp, automatic exposure control setting (mAs) and post-processing algorithms. RESULTS: The results demonstrated that there are advantages to using 90 kVp compared with factors recommended by the manufacturer and in European guidelines. It is also vital that appropriate image processing is selected. CONCLUSION: This study is the first step to optimization, ROC studies are required to unequivocally set the optimum radiographic factors.

1415–1500
Refresher Course
Radiographic Reporting
Olympian Suite

TUESDAY

1415
Invited Review
Perspectives on radiographic reporting: a radiographer, radiologist and accident and emergency consultant discuss their experiences
M J Warren, B Turner, M Kotecha, A Dickens and M Giles
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Luton and Dunstable Hospital is a busy district general hospital with 550 beds serving a predominantly urban catchment population of 290 000. Diagnostic Imaging performs 113 000 examinations per annum, approximately one-third of which are from the Accident and Emergency Department (A&E). Diagnostic Imaging co-operated with the University of Hertfordshire in the development of a post-graduate certificate (PgC) in Radiographic Reporting of the Appendicular skeleton. Three senior radiographers from the Department successfully completed the PgC in December 1996. Following a further period of assessment of practical reporting skills in the Department, and agreement with the Trust Board, these radiographers began formal radiographic reporting in October 1997. Radiographs of patients discharged from A&E were routinely reported by a consultant radiologist, having been passed as either normal, showing insignificant abnormalities, or minor fractures, by the duty A&E junior doctor. However, undiagnosed fractures or other pathology amongst this group of patients present a potential medico–legal risk, compounded by any delays in formal reporting. In order to improve the timeliness and quality of the service, the three radiographers commenced reporting the appendicular radiographs of this group of patients. This new service has been evaluated, both in terms of reporting standards and organizational aspects, including the opinions of other non-reporting radiographers obtained by questionnaire. A radiographer, radiologist and accident and emergency consultant will present their views, discuss the benefits and identify problems through the training and implementation period. The presentation will conclude by making recommendations for other departments intending to introduce radiographic reporting.

1500–1700
Special Focus Session
Film Viewing
Hall 1

1500–1550
Scientific Session
Dynamic Abdominal Imaging
Hall 11b

1500
Real-time 3D electromagnetic imaging of small bowel intubation for enteroclysis
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PURPOSE: Small bowel intubation for enteroclysis is achieved using fluoroscopic guidance. A considerable radiation penalty may be paid if intubation is difficult and prolonged. We report the application of a novel electromagnetic imaging system to achieve intubation without the need for X-rays. MATERIALS AND METHODS: Three sets of generator coils were positioned adjacent to a volunteer's abdomen, each sequentially producing a low strength electromagnetic field. These fields were detected by a series of sensor coils, positioned within a flexible plastic tube, that had been inserted down a 14 F enteroclysis tube (Cook UK). From the electrical signal produced in the sensor coils, their position relative to the generator coils was calculated. A curve was fitted through each of these points to build a graphics image of catheter configuration in 3D, which was displayed on a computer monitor and updated every 0.2 s. The position of the catheter within the volunteer was determined by reference to a series of electronic markers placed on anatomical landmarks. RESULTS: Two male adult volunteers have been studied to date, to determine the technical feasibility of the imaging system for small bowel intubation. Duodenal intubation was attempted without fluoroscopy, solely using the imager for guidance. Fluoroscopy was used subsequently to determine agreement between the electromagnetic imaging system and X-ray. CONCLUSION: Small bowel intubation for enteroclysis without fluoroscopy is technically feasible. The electromagnetic imaging system gives an accurate, real time, 3D representation of catheter configuration within the patient and may have many future applications in radiology.

1510
Imaging and classification of enteroceles using dynamic MRI
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PURPOSE: Introduction of a new method for the dynamic evaluation of enteroceles in women with pelvic floor descent and prolapse. MATERIALS AND METHODS: 11 female volunteers (only MRI) and 41 female patients (aged 32–83 years) with clinically suspected enterocele were investigated with colpocystorectography (CCRG) and dynamic MRI. CCRG was performed in a standard technique with dynamic fluoroscopy (2 frames s^{-1}). MRI was accomplished on a 1.5 T unit. The urethra, bladder, vagina and rectum were opacified. All images were obtained by using a phased array body coil with the subject in a supine position. Initial scanning included axial and sagittal T_2 weighted TSE-images. A midsagittal and axial true-FISP sequence (1 image 1.3 s^{-1}) during pelvic floor contraction and straining allowed dynamic visualization. The pubococcygeal reference line and the content of the hernial sac were used to diagnose and classify an enterocele. The clinical examination, in combination with the intraoperative results, served as "gold standard". RESULTS: MRI revealed an enterocele in 37 patients. Classification included a widening of the rectovaginal septum (two), a peritoneocele (seven), a uterovaginal prolapse (six), an enterocele with small bowel loops (19) and a sigmatocele (three). When compared with the clinical examination, the latter showed a false positive result in four cases with a large rectocele. All cases of enteroceles detected by CCRG (30) could be confirmed by MRI. 11 false positive enteroceles were diagnosed by CCRG. CONCLUSION: Compared with CCRG, dynamic MRI allows better visualization of the size and contents of an enterocele.

1520
The benefits or otherwise of evacuation proctography
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PURPOSE: The clinical relevance of evacuation proctography (EP) is vigorously debated but, although its technical and diagnostic performance has been extensively assessed, no study has investigated

its therapeutic impact. This prospective study aimed to determine this by using a recognized framework to evaluate imaging. MATERIALS AND METHODS: Referring clinicians completed a pre-EP questionnaire, detailing their leading diagnosis, any secondary diagnoses and their confidence in these. They also indicated intended management and what they hoped to learn from EP. After EP the radiological report was returned to the clinician, along with a post-examination questionnaire asking them to state their leading and subsidiary diagnoses in the light of EP, their certainty and what they had learned from EP, if anything. They quantified any management contribution and indicated how useful they found EP generally. Pre- and post-examination questionnaires were compared to determine therapeutic impact. RESULTS: 31 combined questionnaires were evaluated. EP confirmed leading diagnoses in 20 (65%) and refuted it in seven (23%). Unsuspected abnormalities were revealed in 10 (32%) and EP altered intended management in eight (26%). Clinicians stated EP had a therapeutic impact in 25 (81%) of these cases and 29 (94%) found EP generally useful. CONCLUSION: The aetiology of severe constipation remains obscure and treatment is frequently ineffective, therefore the influence of EP on diagnostic confidence and management are more appropriate measures of clinical utility than patient outcome. This study is the first to quantify the therapeutic impact of EP, proving it to be of major benefit to requesting clinicians.

1530

Dynamic MRI defaecating proctography—a new method for assessing anorectal dysfunction?

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PURPOSE: Disorders of defaecatory function are common. Evaluation requires a combination of invasive procedures, some involving ionizing radiation. None individually evaluate the function of the entire pelvic floor. This may contribute to the high failure rate for surgery performed on the basis of these investigations. Interventional MRI scanners (IMR) allow real-time imaging in physiological positions without ionizing radiation. The aim of this study was to develop a technique for investigation of defaecatory dysfunction in the IMR, combining functional evaluation with soft-tissue imaging. METHODS: Eight female patients (median age 63 years, range 21–83 years) were examined in a 0.5 T IMR unit. Six patients had defaecatory difficulty, including incomplete evacuation, excessive straining or the need for self-digitation. Examination was normal, except for an anterior rectocele in two cases. One patient complained of faecal incontinence (examination revealed poor sphincter tone) and one had full thickness rectal prolapse. The patients were seated on a plastic bedpan with the anorectal region at isocentre. A loop transmit/receive coil was placed under the bedpan. Gadolinium-DTPA (0.1 mmol kg^{-1} iv) was administered to aid bladder visualization in six patients. Dynamic real-time images were acquired at rest in mid-sagittal and coronal planes (FGR, acquisition time 4 s). Imaging was then performed during maximal squeeze and straining manoeuvres. This was followed by rectal administration of 200 ml of mashed potato, reconstituted with 1% gadolinium-DTPA in water. Whilst real-time imaging continued, the patients were asked to empty the rectum and signify when they felt defaecation was complete. The images were assembled into a cine loop for assessment of defaecatory dynamics. RESULTS: All patients tolerated the procedure. The pelvic organs and soft tissues were clearly visualized and rectal contrast was excellent. The levator ani muscles were visible in the coronal plane. No patient had asymmetrical levator contraction. Intravenous contrast markedly improved bladder visualization. The rectal prolapse was clearly visualized. In five of the other patients an anterior non-emptying rectocele was identified, with intrarectal mucosal intussusception in two. Abnormal bladder neck descent was demonstrated in four patients. The patient with sphincter weakness was unable to retain the contrast material. In the final patient, failure of relaxation of the puborectalis (anismus) was demonstrated. CONCLUSION: This technique evaluates defaecatory function in a physiological position, without exposure to ionizing radiation. It gives information concerning the whole pelvic floor. The technique demonstrated a significant abnormality in patients with defaecatory dysfunction when physical examination was negative or inconclusive. Further work is needed comparing this technique with established investigations of defaecatory function.

1540

Faecal incontinence in scleroderma: assessment of the anal sphincter using high resolution endoanal MRI

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PURPOSE: To describe the appearances of the anal sphincter in faecally incontinent patients with scleroderma using an endoanal coil and to compare them with patients with faecal incontinence, but without scleroderma, as well as with those with asymptomatic scleroderma and non-scleroderma controls. METHODS: 37 patients were studied: 14 (12 female, two male) had scleroderma and faecal incontinence, 13 females had faecal incontinence but no scleroderma, four females had scleroderma but no faecal incontinence, and six (four female, two male) had no evidence of scleroderma or faecal incontinence. T_1 and T_2 weighted spin echo sequences in multiple planes, magnetization transfer weighted scans and single slice dynamic gadolinium enhanced scans were acquired. Images were analysed for integrity, thickness and length of the sphincter components. Magnetization transfer ratios, T_2 relaxation times and percentage enhancement above baseline at 30 s intervals were calculated. RESULTS: 11 of 14 faecally incontinent patients with scleroderma showed descent of rectal contents into the anterior anal canal, with forward deviation of the internal sphincter. This group showed significant atrophy ($p<0.05$) and a slower enhancement pattern of the internal sphincter compared with other groups. Faecally incontinent patients without scleroderma showed no internal sphincter deviation or altered vascularity, but had a significant reduction ($p<0.05$) in deep external sphincter bulk. There were no significant differences in magnetization transfer ratios or T_2 relaxation times of the internal sphincter between the groups. CONCLUSION: High resolution endoanal MRI defines muscle bulk of the anal sphincter components and helps identify the anatomic cause of incontinence. It delineates the deformity and abnormal vascularity of the internal sphincter in faecally incontinent patients with scleroderma.

1515–1705 Scientific Session **Skill Mix** Olympian Suite

1515

Invited Review

Radiographer reporting—audit of performance at 2 years

J S Raynor

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The concept of radiographer reporting has been pursued at Macclesfield District General Hospital since 1991. An initial idea for a research project into the diagnostic capabilities of radiographers has flourished to such an extent that, less than 4 years later, two radiographers were able to take over the responsibility of reporting a significant proportion of the trauma referrals. The number of examinations seen by the radiographers over these 2 years has been audited in respect of the type of examination, the number of independently reported films, the referrals for a second opinion and the films routinely monitored by the radiologists. The reasons for referral of films to a radiologist have been analysed, alongside the types of examination most commonly referred. The discussion will be centred upon the implementation of the reporting system within the Trust and its associated problems; the benefits to the radiology department, the individual radiographer and the radiographic profession as a whole.

1545

Radiographer role development in a district general hospital

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Following the publication of *Röntgen's Progress* by the Royal College of Radiologists in 1994 we examined the balance of work in our departments. An increasing volume of US, barium enemas and CT referrals was producing long waiting times and problems with service provision. The balance of work between radiologists and radiographers was reviewed and, following an open meeting, radiographers volunteered for training to perform barium enemas.

The sonographer's role has expanded, with an increasing work-load in urological and general abdominal scanning. Previously, the sonographers were almost exclusively concerned with obstetric US. There has been considerable reduction in waiting times for certain procedures. The radiographers have received training in iv injections, which has greatly facilitated the performance of iv urography and the use of the CT scanner. The majority of iv injections are now given by radiographers. We currently have two radiographers training in clinical reporting. The changes in the department have had significant positive effects on staff morale. No radiographer has been asked to change their role unless they were confident and received appropriate training. There has been support from clinical colleagues, both in the hospital and in the community. Further areas for role expansion of radiographers are being considered, including venography and vascular Doppler examinations. However, there have been concerns, particularly about medico legal aspects and staff grading. Moreover, it has not always been easy to implement changes with a downward pressure on staffing levels to meet cash releasing efficiency savings (CRES) targets.

1555

Double contrast barium enema performance: evaluation of three different investigators

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PURPOSE: To determine whether there are any differences in performance of double contrast barium enema (DCBE) between a consultant radiologist, trainee radiologist and fully trained radiographers. MATERIAL AND METHOD: 138 unselected consecutive patients who underwent DCBE were retrospectively reviewed on a blinded basis. 45 examinations were performed by a consultant, 46 by Year 1–3 trainee registrars and 47 by two fully trained radiographers. Examinations were compared for diagnostic acceptability, screening time, patient absorbed dose and number of films taken. RESULTS: There were no significant differences between the three groups for three of the four parameters evaluated *i.e.* diagnostic acceptability, absorbed dose and screening times. There was a significant difference between radiographers and trainee registrars in the number of films taken. Radiographers took the most films, range 10–18 (mean 15.7) compared with trainee registrars who took the least films, range 9–19 (mean 13.6). CONCLUSION: Although radiographers took significantly more films than trainee radiologists, we feel this is acceptable practice. The lack of significant differences between the three groups for diagnostic acceptability, screening times and patient absorbed dose confirms the overall impression that trainee radiologists and suitably trained radiographers can perform DCBE to highly acceptable standards.

1605

A comparison of double contrast barium enemas performed by radiographers and consultant radiologists

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PURPOSE: Double contrast barium enemas provide a significant work-load for radiologists, with many departments now extending the role of the radiographer to include screening. In 1995 three superintendent radiographers were taught the technique of double contrast enemas and subsequently allocated regular lists of outpatients. The quality of these enemas was assessed. METHOD: In the 3 month period studied radiographers performed 18%, registrars 41% and consultants 41% of the total number of enemas. The average age of these patients was 47, 67 and 70 years respectively. To allow for this age difference, 25 enemas performed by radiographers were age-matched with consultant examinations. All films for each enema were assessed and ranked blindly for barium coating, double contrast demonstration, colonic distension and unobscured sigmoid visualization. The screening times and film usage were compared. Data were collected on the referring clinician, indications and limitations. RESULTS: A higher proportion of the patients screened by radiographers were referred by GPs. There was no significant difference in the quality of enemas performed with respect to the four variables assessed. Scores of adequate or better were obtained by the radiographers for barium coating, double contrast demonstration, colonic distension and unobscured sigmoid visualization in 92%, 88%, 72% and 76%, respectively, compared with 76%, 68%, 76% and 76%, respectively, by consultants. There was also no significant difference in the screening times or film usage. CONCLUSION: Adequately-trained radiographers can provide a safe and effective service performing double contrast barium enemas in selected patients.

1615

Trauma radiology: extending the Red Dot system

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PURPOSE: We assess the ability of experienced casualty radiographers and emergency nurse practitioners (ENPs) to triage radiographs in appendicular trauma, separately and when working together. METHODS: Radiographs of consecutive patients attending the Minor Injuries Unit of the Accident and Emergency Department in a large district general hospital were triaged, first by the examining radiographer into two categories *viz.* "No important abnormality" and "Important abnormality". In addition to the usual Red Dot, radiographers were instructed to specify the abnormality where present by briefly annotating a label affixed to the film packet. Radiographs were then triaged by the examining ENP with the knowledge of the radiographer's observation. The radiologist's report was used as the "gold standard". The study was repeated just using the Red Dot system without further radiographer input. RESULTS: The diagnostic accuracy for: radiographers' triaging alone was 89%; ENP triage with just the Red Dot was 77%; and combined triage with specific observations 92%. Sensitivities were respectively 85%, 83% and 94%. CONCLUSION: These figures reinforce the value of multiple reading, with obvious immediate benefit to the patient and clear implications for reducing recall rates. This benefit is largely due to the simple, but effective, communication of important specific abnormalities by radiographer to clinician which, in our opinion, usefully extends the role of the radiographer beyond the Red Dot system.

1625

Radiographic reporting: subject performance in assessment as a function of specific demographic factors

I Henderson

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Radiographic reporting is an activity which appears to be gaining widespread acceptance in diagnostic radiology, where departmental managers are seeking to develop effective use of resources. As this is a significant development in the role of the radiographer, the selection of students to take part in radiographic reporting has been an important factor in seeking to ensure a high quality outcome. As yet, relatively few students undertaking formal education programmes in radiographic reporting have passed through individual centres. The programme in reporting of the appendicular skeleton at South Bank University has now been underway for 3 years and has overseen four cohorts ($n=25$). It is now possible to make some preliminary statistical observation regarding the performance of subjects in relation to their "demographic" origin. In the context of a more extensive study, this analysis was carried out with the objective of investigating relationships between the identified factors: gender, age, experience, professional grade and performance of subjects. Subject performance was measured in an entry baseline-reporting assessment, and a summative reporting assessment carried out at the culmination of a significant developmental stage in the programme. Preliminary analysis indicates a mild negative correlation between subject age and performance at the summative stage, though not at the entry point. Other factors do not appear to have a significant bearing on performance. This information should be of value to those considering the development of departmental strategies in relation to reporting and the selection of prospective students.

1635

A GP based US service

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US is now becoming a popular imaging modality in general practice; this study assessed the accuracy and effectiveness of US by general practitioners (GPs) in the surgery setting. We present an audit of the first 18 months and discuss the appropriateness of US performed by GPs. A range of US examinations in two four-partner practices were studied. The examinations were made by four of the partners under supervision, utilizing high resolution portable and a static US scanner. Altogether 500 scans were performed in a wide range of US examinations, 299 (59.8%) of the patients were saved referral to the local hospitals' US departments, 147 (29.4%) scans had a major affect on the clinical management of the patients. 54 (10.8%) patients were referred on to the US departments for clarification of results, either due to the limitations of the US machine or the nature of the pathology. This study has shown that US can be performed accurately by adequately trained GPs and has a major influence on

a variety of clinical conditions. A general-practice based US service is able to take some of the work-load from the local hospital US department in a well-defined range of examinations.

1645
Hysterosalpingosonography, an ultrasonographer led service
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AIMS: Hysterosalpingosonography (HyCoSy) has not been universally adopted into routine clinical practice, perhaps due to the level of expertise required in transvaginal scanning (TVS). Many radiographers have achieved this level of scanning experience from gynaecology clinics. This centre has developed a training programme to provide an ultrasonographer-led HyCoSy service. The aim of this paper is to determine its success. METHOD: 78 patients were scanned. 59 were scanned by one of three ultrasonographers and 19 by one of two gynaecologists. Technical aspects of each examination, including procedure time, time to complete cannulation of the cervix, contrast dose and adverse events were recorded. RESULTS: Successful cannulation was achieved in all 78 examinations, the time taken by the ultrasonographers (13.8 mins $\pm$ 4.0) was similar to the gynaecologists (14.5 mins $\pm$ 7.8). The volume of contrast used by the ultrasonographers was significantly less than the gynaecologists (15.6 $\pm$ 3.8 *vs* 21.6 $\pm$ 9.3 ml; $p = 0.02$). There was no significant difference in time taken to obtain hard copy or video of the examination (13.8 $\pm$ 1.5 *vs* 21.6 $\pm$ 11.6; $p = 0.5$), nor was there any significant difference in recovery time between the ultrasonographers and the gynaecologists, 16.9 mins $\pm$ 1.4 compared with 30 min $\pm$ 15. However, those examined by ultrasonographers complained of fewer adverse effects (19% *vs* 30%; $p = 0.02$). CONCLUSIONS: The ultrasonographers found catheterization skills easy to learn and had few difficulties in identifying the Fallopian tubes. These results demonstrate that extending the role of ultrasonographers is a viable alternative to a gynaecologist-lead HyCoSy service.

1655
Visual search strategies for the lateral cervical spine image
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[1]*Division of Allied Health and* [2]*Applied Vision Research Unit, University of Derby, Derby, UK*
PURPOSE: There is increasing evidence to suggest that there is a need for radiographers to extend their existing roles in the area of image interpretation and reporting (IIR). This study assesses the efficacy of image interpretation, by examining the visual search strategies for lateral cervical spine images of subjects, with differing image interpretation experience. MATERIALS AND METHODS: The visual search behaviour of 35 subjects was recorded, whilst interpreting a series of lateral cervical spine images, using remote eye movement detection equipment. Subjects included radiographers, radiologists and lay readers, each of whom were asked to interpret the images and state their confidence in the presence or absence of a cervical spine fracture. Analysis of visual search behaviour was made, together with analysis of the decisions made using rating scales. RESULTS: Data indicated that radiographers could effectively search images in a manner comparable with that of expert readers, such as radiologists. Receiver operating curve (ROC) analysis indicated that they were not as effective in making accurate decisions about the presence of a fracture compared with radiologists. CONCLUSION: We argue that, with appropriate training, further improvements in the decision-making performance of radiographers could be made. It is our contention that these results provide further justification for extending the radiographer's role in IIR.

1545–1700
Debate
This House Believes Predictive Assays Have a Role to Play in Radiotherapy—Summing Up
Hall 10b

Moderator
J Hendry
CRC Research Centre, Christie NHS Trust, Manchester M20 4BX, UK

1545–1715
Controversy Corner
*info*RAD™ 4—IT Security in the NHS
Hall 11a

1545
Invited Review
Security principles and how they apply to the NHS
S Hayes
Insight Consulting, Walton-on-Thames, Surrey KT12 2TZ, UK
The NHS is a group of autonomous organizations providing primary and secondary healthcare to the population of the UK. It also covers a number of other ancillary, but vital, services including research, social services, laboratory services, communicable disease control, purchasing and supplies etc. Outside the immediate NHS environment, there is a growing number of third parties providing facilities-managed services, hosted either on the company's own site or on the NHS organization's site. The need for a common approach to communications within the NHS is growing. There have been numerous cases of lost records, late delivery of laboratory test results, patient details being delivered to the wrong place, emergency information on drugs not reaching clinicians, unknown availability of treatments etc. These have resulted in mistreatment, litigation and, in some cases, patient death. There are a number of issues to be addressed which are unique to the medical profession. Clinical staff (consultants, general practitioners, psychiatric staff, nursing staff etc.) have an ethical obligation to protect the privacy of their patients information. They also have a duty of care—that is, providing the best possible treatment available to them. To achieve this they need to be able to have access to, and be able to provide, information in a secure manner. The overall objective for the NHS-wide networking programme has been to provide any-to-any connectivity nationwide, throughout the NHS, reducing duplication and achieving economies of scale by supporting direct links to a number of national applications and certain value-added services and external (non NHS) networks and systems. This enables the effective, legitimate sharing of medical, patient and management information and administrative data. The security principles applied are those that can effectively be achieved by a privately managed network. That is: access is restricted to authorized users only; the network is only used for the purposes for which it is intended; the network is available when and where required. It is also essential that information on the network: has not been modified, accidentally or deliberately, without appropriate authorization; has not been inserted or deleted; is presented in the correct sequence. This does not, however, solve all the issues, only provides a platform upon which improved security services can be built. There remains an obligation on the owner of the information, or system hosting that information, to provide adequate and appropriate levels of protection for storage and transmission. This will mean improved procedures for authorization, improved levels of user authentication and access control, and better data protection and validation measures. These services are becoming more readily available in standard products and must now start to be applied in a consistent manner; minimizing the risk to the NHS and maximizing the opportunity for improved patient care.

1610
Invited Review
Are we over-reacting to security issues?
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There has been a long debate over the issues of security for healthcare systems. This debate was triggered by plans for an NHS wide network to link many of the healthcare systems of England and Wales. The British Medical Association (BMA) set itself in opposition to these plans and commissioned a study to address what it purports to see as serious security issues. In this author's view, however, the debate is largely misdirected and poorly informed. Available evidence of security breaches of clinical information systems in the UK suggests that these are exceedingly rare. It is prudent to take reasonable precautions against reasonable hypothetical risks about security. It is not prudent, however, to cripple the introduction of beneficial healthcare technology by addressing endless "nightmare scenarios" for which there is no firm evidence or clearly established motivation. It is difficult, therefore, to support the

introduction of draconian, technically-enforced security measures. Genuine contention about security, as opposed to political rhetoric, appears to be more about the disclosure of clinically confidential information for NHS managerial purposes than about computer security. Unfortunately, resulting proposals seem likely to have an adverse effect on beneficial healthcare computer systems and their continued introduction. If the real objection is the disclosure of clinical information for NHS management purposes, then it would be better to address this matter directly, rather than deny everyone the benefits of healthcare systems.

1635
Invited Review
Computer security—a suitable case for treatment
N A C van der Bijl
Southmead Health Services NHS Trust, Bristol BS10 5NB
The ultimate aim of computer security is to protect the electronic data held within the computer system, irrespective of whether it is on a PC or e-mail. Computerized information is of an explicit nature but has three qualities that must be preserved—integrity, availability and confidentiality. Quite apart from natural hazards, malfunctions and errors caused by user unfamiliarity, complacency and poor training, computers and their communications links have vulnerabilities and weaknesses which can be improperly exploited - sabotage by disenchanted employees, vandalism, pressure groups, terrorism and competitors—by rerouting and copying information, destruction and amendment and modification of programs. The question that should be asked by every user when they switch on is "Can I be sure that my information has not been accessed without my authority?". The defence of computerized information is not difficult. A computer security policy is critical so that staff know their responsibilities. Physical security to protect the installations must be in depth to slow down intruders and buy time and highlight weaknesses. The information must be properly cared for as though it were hardcopy. Are those who use computers competent, reliable and honest? How is this checked? A disaster plan must be written to limit the damage in the event of a computer malfunction or unauthorized penetration.

1700
Radiology networks
D S Hicks
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The problems involved in networking imaging modalities to workstations, image archives (PACS), teleradiology systems and laser printers have become crucial issues for radiology managers. Technology is changing very rapidly, driven on by the PC industry and the prospect of rapid obsolescence which, together with the need for a planned upgrade strategy, are very real issues when developing a new network. As facilities are more commonly shared between hospitals, very large amounts of imaging data has to be transmitted over wide area networks. As imaging data becomes more accessible, privacy and patient confidentiality become more difficult to control. Network technology and topology will be discussed, both in terms of the physical level, *i.e.* the cable and equipment, and in terms of software, including the latest DICOM standards. The topology of the common ethernet standard will be reviewed and compared with that of switched networks. Typical types of cables used, including fibreoptic cable, will be discussed and approximate costs presented. The issue of local network speed and integrity will be considered, together with the security issues involved in using the digital telephone network (ISDN).

1710
Discussion

1600–1650
Scientific Session
Gastrointestinal Tract
Hall 11b

1600
Pain after small bowel meal and pneumocolon: randomized controlled trial of CO_2 *vs* air insufflation
L R Gellett, R Farrow, C Bloor and G Maskell
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The use of pneumocolon (PC) during small bowel meal (SBM) improves visualization of the terminal ileum, but may be associated with pain and distension. 100 patients presenting for SBM and PC were randomized to receive either air or carbon dioxide (CO_2) as the gas for insufflation. Patient and radiologist were both blinded to the gas being used. Patients were given a questionnaire to complete the following day. The degree and duration of abdominal pain and swelling were recorded on a visual analogue scale. Pain and swelling were scored from zero to 100. 79 patients replied. The mean pain score was 28.1 for patients receiving air and 20.35 for those receiving CO_2 ($p<0.05$). The duration of pain was 9.0 h in the air group and 6.0 h in the CO_2 group ($p<0.05$). The mean abdominal swelling score was 27.1 for patients receiving air and 17.1 for those receiving CO_2 ($p<0.05$). The duration of swelling was 8.8 h in the air group and 7.3 h in the CO_2 group ($p=0.16$). In patients presenting for SBM and PC, the severity and duration of abdominal pain and swelling are significantly reduced by the use of CO_2 rather than air.

1610
Identifying a high risk group for colorectal neoplasia from the barium enema request form
J R Steel, G K L Tai and N J Ring
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PURPOSE: To determine which request form details can predict the finding of colorectal neoplasia on barium enema. METHODS: Retrospective analysis of 805 consecutive out-patient barium enema results with correlation to the request form details was performed. Information analysed included age, sex, clinical presentation, relevant past and family history, other investigations and whether urgent examination was requested by the referring clinician. Patients with carcinoma and patients with polyp alone were compared with those without either carcinoma or polyp. Logistic regression was used to identify significant predictors for carcinoma and polyp. RESULTS: Colorectal carcinoma was found in 31 (3.9%) and polyps, without coexistent carcinoma, in 38 (4.7%). Significant positive predictors of carcinoma were anaemia, palpable mass, known inflammatory bowel disease, known tumour on rectal examination or sigmoidoscopy, age and requests deemed clinically urgent. Significant positive predictors of polyp were anaemia, rectal bleeding, mucus per rectum, known tumour on rectal examination, clinically urgent request and age. The youngest patient with either carcinoma or polyp was 47 years old and for both carcinoma and polyp the risk increases with age. Patients with at least one of the positive predictors for carcinoma comprised 28% of the total group, but 74% of the patients with carcinoma and 58% of those with polyp. CONCLUSION: Those patients with either anaemia, a palpable abdominal mass, known inflammatory bowel disease, tumour on rectal examination or sigmoidoscopy or a clinically urgent request should be prioritized for barium enema examination.

1620
Contrast agent for imaging the colon—is there a way forward?
J E Morris
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PURPOSE: Current imaging of the colon includes the rectal introduction of a contrast agent. This paper examines the viability of orally introducing the contrast agent, resulting in a more patient-friendly examination. METHOD: A histological, biochemical and physiological study was made to determine how best to target the bowel and ensure delivery to the correct site, in such a way that diagnostic information, comparable with that currently provided by a barium enema, can be obtained. RESULT: It is possible to deliver an enterically-coated substance to the colon so that the agent is activated by the bowel pH level. The target area, mucus consisting of oligosaccharides, can be utilized as the link between the bowel lumen and contrast agent. CONCLUSION: Colonic mucosal oligosaccharides present a viable target as the binding agent between the bowel lumen and contrast agent. Using prodrugs and enteric-coating techniques, the contrast agent can be effectively delivered to the target site. This method of delivery increases patient tolerance of a procedure acknowledged as both distressing and invasive. The reduction of operator preparation time, alongside the possible reduction of patient dose due to reduced imaging times, are also important considerations which recommend continued investigation.

1630
Prospective, blinded assessment of 3D spiral CT pneumocolon in the staging of colonic cancer
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PURPOSE: To determine the accuracy of 3D pneumocolon in staging colon cancer. METHOD: 43 patients [22 female; 21 male, mean age 67 years (44–88)] underwent dynamic contrast-enhanced spiral

CT after bowel preparation, iv Buscopan and rectal air insufflation. Imaging (5 mm collimation, pitch 1.5, reconstruction 2.5 mm) was started 25 s after injection of 150 ml iv contrast at 5 ml s^{-1}. Pathologic correlation was obtained in all patients, 37 underwent surgical resection, six had multiple biopsies. Radiological features after work-station assessment were wall thickness (abnormal > 3 mm), wall contour, soft tissue invasion, altered pericolic fat attenuation, lymphadenopathy (short axis > 10 mm) and distant metastases. Lesions were staged by Duke's classification. RESULTS: There were 31 cancers (two Duke's A, 15 B, 11 C and three D), 11 benign lesions and one normal. 24/31 carcinomas were correctly staged. Wall invasion was accurately assessed in 30/31. Lymph node involvement was correctly diagnosed in 25/31. Five patients had normal sized nodes which contained tumour, one had reactive node enlargement. Benign lesions were correctly differentiated from malignant in 9/11 cases. No malignant lesion was misdiagnosed. CONCLUSION: Spiral CT pneumocolon proved highly accurate in defining pericolic invasion. Malignant normal sized nodes remain problematic. This technique facilitated differentiation of benign from malignant lesions.

1640

Percutaneous abdominal and pelvic interventional procedures utilizing CT fluoroscopic guidance

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PURPOSE: CT fluoroscopic imaging has been introduced recently for clinical use. We assessed its use for guidance of percutaneous diagnostic and therapeutic procedures in the abdomen and pelvis. MATERIALS AND METHODS: 114 percutaneous diagnostic and therapeutic procedures were performed in 105 patients over a 1 year period: these included fluid aspiration/drainage catheter insertion ($n=59$), biopsy ($n=42$), hepatoma alcohol ablation ($n=5$), chemoneurolysis ($n=4$), gastrostomy or brachytherapy catheter insertion ($n=4$). Guidance was performed by a helical CT scanner with near real-time (0.14 s lag time) reconstruction at six frames s^{-1} (Xpress/SX, Toshiba, Tokyo, Japan). A control panel and video monitor beside the gantry allowed direct operator control during interventional procedures. RESULTS: 108 (95%) procedures were successfully performed utilizing either continuous CT fluoroscopy during needle/catheter placement, with stand-off needle holders, or intermittent CT fluoroscopy to confirm position following manual needle/catheter placement. Image quality using low (30–60) mA was adequate for needle/catheter placement in all but three low contrast liver lesions. Organized hematoma prevented fluid aspiration in two cases and development of endotoxic shock precluded attempted abscess drainage in another. CT fluoroscopy allowed rapid assessment of needle, guide-wire, dilator and catheter placement, especially along non-axial planes. Imaging of alcohol distribution during injection facilitated tumour ablation and neurolytic procedures. Average CT fluoroscopy time for biopsy and therapeutic procedures was 127 (range 37–336) s and 186 (range 20–660) s, respectively. CONCLUSION: Initial experience suggests that CT fluoroscopy is a practical clinical tool which facilitates rapid and effective performance of percutaneous abdominal and pelvic interventional procedures.

1615–1700
Refresher Course
Practical Aspects of Dental Radiography
Hall 10a

1615

Invited Review

Practical Aspects of Dental Radiography

S M Bourne
St Bartholomew's and The Royal London Hospital School of Medicine and Dentistry, London E1, UK

This lecture will include a discussion of intraoral techniques with demonstration of pitfalls encountered and how to overcome them. The advantages and disadvantages of dental panoramic tomography will be discussed, together with positioning and how to improve images. Dental radiography in children will also be covered and practical suggestions made in response to any particular problems arising from the session.

Notes

Wednesday 3 June

0800–0850
British Institute of Radiology
Annual General Meeting & Awards Ceremony
Hall 9

0800–0850
Scientific Session
Bone Mineral Density Measurements
Hall 10a

0800

Broadband US attenuation fails to select patients who should have DXA bone densitometry

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INTRODUCTION: Bone densitometry is important in the diagnosis of osteoporosis. Currently, the preferred method of determining bone density is dual energy X-ray absorptiometry (DXA) of the axial skeleton. However, this technique involves small doses of ionizing radiation, is relatively expensive and not portable. Broadband US attenuation (BUA) is a technique of bone densitometry which does not use ionizing radiation, is relatively inexpensive and portable. These attributes provide potential for its use in the community. PATIENTS AND METHODS: 301 patients (264 women and 37 men), aged 31–81 years, were attending the Department of Diagnostic Radiology for bone mineral density (BMD) measurements because of suspected osteoporosis. BMD was measured in the lumbar spine (L1–L4) and proximal femur (femoral neck, trochanter and Ward's area) using a lunar DPX-L scanner. Cortical BMD in the forearm was measured by single X-ray absorptiometry (SXA-Osteometer DTX-100). BUA of the calcaneum was performed on a McCue Cuba Clinical scanner. BMD was expressed as a standard deviation score of age- and sex-matched means values (Z-scores). A Z-score > -2 was normal; values < -2 were considered to be osteoporotic. RESULTS: Although there was some correlation between DXA of the spine and SXA in the same individual ($r = 0.4538$) there was no correlation between photon absorptiometric measurements (DXA) and BUA ($r = -0.0737$). However, it is not possible to predict from one BMD measure what would be obtained by another method in the same individual in the same, or a different anatomical site. Individuals were categorized as normal or osteoporotic for each measurement made using κ statistics. In a large number of individuals BUA failed to categorize as normal or osteoporotic in concordance with DXA results. CONCLUSION: The study indicates that BUA does not have the sensitivity or specificity to support its role in the community as a technique which could identify those individuals who would benefit from referral for more scarce and expensive measurements of bone densitometry (DXA).

0810

Are peripheral bone mass measurements of clinical use in the diagnosis of spinal osteoporosis?

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INTRODUCTION: The only secure basis on which to make a diagnosis of osteoporosis, if fragility fractures are not present, is by the use of bone densitometry. The principal technique established in clinical practice is dual energy X-ray absorptiometry (DXA), applied to the lumbar spine and proximal femur. Studies of peripheral bone density measurements demonstrate reasonable sensitivity and specificity for vertebral fracture. However, analyses do not indicate the risk of osteoporosis associated with any particular value and are of little clinical applicability. We have used a Bayesian approach to determine an individual's likelihood of having spinal osteoporosis, based on peripheral bone mass measurements. PATIENTS AND METHODS: 266 women with suspected osteoporosis were referred for bone densitometry of the spine (L1–4) and femoral neck using DXA (Lunar DPX), in the forearm cortical bone by single X-ray absorptiometry (SXA Osteometer DTX 100) and in the calcaneum by broad-band US attenuation (BUA—McCue Cuba Clinical). Spinal osteoporosis was diagnosed if the vertebral standard deviation from mean peak bone mass (T-score) was less than -2.5 (WHO criterion for osteoporosis). For each decile of the other techniques the probability of spinal osteoporosis was calculated. RESULTS: There was a strong relationship between the decile of bone mass and risk of spinal osteoporosis for DXA of the femoral neck and SXA of forearm cortical bone ($r_s = -0.96$ and -0.98 respectively, both $p < 0.001$), but not with BUA ($r_s = 0.25$, $p = 0.48$). CONCLUSION: Both DXA of the femoral neck and SXA of the forearm provide clinically useful information about the risk of osteoporosis of the spine, whereas BUA of the calcaneum does not. Scanners which provide information of bone density in the forearm (SXA, pDEXA), and which are relatively inexpensive and portable, may therefore have a role in the community in the diagnosis of osteoporosis and those individuals at risk of fracture.

0820

Pregnancy-associated osteoporosis: long-term bone mineral density follow-up

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Symptomatic improvement in pregnancy-associated osteoporosis is common, but evidence of improved bone mineral density (BMD) is sparse. 13 patients with pregnancy-associated osteoporosis had serial measurements of lumbar spine and hip BMD by DXA 0–10 years after a symptomatic pregnancy. Eight presented with back pain; all had radiographic vertebral collapse. Spine BMD was initially very low (mean Z-score -3.49, range -2.25 to -4.66, up to 6 months post-partum); hip BMD was less markedly reduced (mean Z-score -1.97, range -1.44 to -2.32). Spine BMD improved in all patients, especially in the first year, continuing up to 7 years, but remained below normal (mean Z score -1.94 at 7–10 years post-partum); in most of these patients hip BMD showed a similar recovery. Five patients had hip pain and MRI features of transient osteoporosis of the hip. In these patients, hip BMD in the first 6 post-partum months was low (mean Z-score -2.19, range -0.09 to -3.26); spine BMD was similarly reduced (mean Z-score -2.00, range -1.48 to -2.65). Both hip and spine BMD rapidly improved in the following year, reaching the normal range within 2 years, with continued increase in hip BMD up to 6 years. In all 13 patients, the initial and subsequent BMD Z-scores at the two sites were significantly correlated ($r = 0.72$, $p < 0.001$). The consistent improvement in BMD after the affected pregnancy makes it likely that the low bone density was related to the pregnancy, rather than to pre-existing osteoporosis.

0830

Trabecular and cortical bone structure and bone mineral density: a multiparameter assessment of the degree of osteoporosis in comparison with the fracture load

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PURPOSE: Recent studies indicate that a combination of different parameters can improve the estimation of the individual fracture risk in osteoporosis. In this study, we combine trabecular and cortical structure and bone mineral density (BMD) with a new parameter which is verified against the fracture load of vertebral bodies. MATERIALS AND METHODS: 21 vertebral bodies from five cadavers with different degrees of demineralization were studied. Cortical and trabecular BMD were determined separately (SE-QCT/85kV, Somatom DRH). Five high resolution CT slices, centred around the mid-vertebral section, were obtained for each vertebra, where the corticalis and spongiosa were segmented and a structural parameter determined individually for the spongiosa (fractal dimension in dependency of the binarization threshold) and the corticalis (low-BMD cluster count). The vertebrae were then excised and compressed until fractured. RESULTS: All four parameters (cortical and trabecular BMD, cortical and trabecular structure) allowed us to distinguish between the osteoporotic and non-osteoporotic subjects. Correlation coefficients of the parameters with the fracture load were determined as $r_1 = -72\%$ (trabecular structure), $r_2 = -86\%$ (cortical structure), $r_3 = -81\%$ (trabecular BMD), and $r_4 = -82\%$ (cortical BMD). A weighted sum of all four parameters showed a correlation with the fracture load of $r_{sum} = 88\%$, with $p \leq 0.0001$ in all cases. CONCLUSION: The introduced

non-invasive parameters show a high accordance with the fracture load. The higher correlation of the cortical parameters indicates the important contribution of the cortical shell to the stability of the vertebrae. Combining these parameters increases the correlation coefficient and thus leads to the expectation of an improved assessment of the individual fracture risk.

0840

Spinal bone mineral density in Paget's disease using dual energy absorptiometry and quantitative CT

[1]R A Cherian, [2]M J Haddaway, [2]I W McCall and [3]M W J Davie
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PURPOSE: Spinal bone mineral density measurements are frequently undertaken in the older population to assess the degree of osteoporosis. The purpose of this study was to assess the implications of vertebral involvement on bone mineral density measurements in patients with Paget's disease. MATERIALS AND METHODS: 28 patients with Paget's disease had quantitative CT (QCT) (Siemens DRH) and dual energy absorptiometry (DXA) (Hologic QDR-1000) studies at the L2–L4 vertebral levels. QCT measured cortical and trabecular components, while DXA provided integral bone mineral density measurement. Radiographs and isotope scans were used to designate individual vertebral levels as Pagetic (PSP) and non-Pagetic (NPSP). RESULTS: Mean DXA values for Pagetic(29) and non-Pagetic (53) vertebrae were 1.24 (SD+0.414) and 1.024 (SD±0.201) $g\,cm^{-2}$, respectively ($p=0.002$). Mean trabecular and cortical QCT in pagetic bone (127.3 and 355.8 $mg\,cm^{-3}$), was higher than for unaffected vertebrae (88.94 and 289.18 $mg\,cm^{-3}$), ($p=0.01$ and 0.04, respectively). In PSP vertebrae, DXA correlated with cortical ($r=0.842$, $p<0.001$) and trabecular ($r=0.649$, $p<0.001$) QCT; in NPSP, values were $r=0.66$, $p<0.001$ for cortical, and $r=0.505$, $p<0.01$ for trabecular QCT. The mean ratio of trabecular to cortical bone was 0.363 in the PSP group and 0.318 in the NPSP group (p=ns). DISCUSSION AND CONCLUSIONS: DXA and QCT measurements were significantly higher in Pagetic vertebrae. Bone mineral density, as evaluated by DXA, is less well-reflected by trabecular QCT, indicating the greater contribution of cortical bone to the composite bone density measurement. The relative change in trabecular and cortical bone is the same for Pagetic and non-Pagetic bone.

0800–0850
Scientific Session
Cardiac Imaging
Hall 11a

0800

CT dimensions of the normal pericardium

R K Bull, P D Edwards and A K Dixon
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PURPOSE: Previous studies have concluded that the upper limit of the thinnest portion of the pericardium is 3–4 mm using 10 mm CT slices. They also stated that the pericardium was not identified in all patients. These studies, however, suffered from small sample sizes, long data acquisition times and unconventional viewing parameters. It was our impression, using modern CT equipment, that the pericardium was seen in all patients when using a slice thickness of 10 mm and mediastinal window settings, and that its upper limit of minimum thickness was considerably less than 3–4 mm. In addition, we noted that, although the pericardium is well seen on 1 mm HRCT images at mediastinal window settings, there had been little reported about HRCT appearances of the normal pericardium. MATERIALS AND METHODS: The width of the thinnest portion of the pericardium was measured using 10 mm standard CT (100 patients) and 1 mm HRCT slices (100 patients) using modern CT equipment and fixed mediastinal window settings (400/20). RESULTS: The pericardium was identified in all patients studied and was best seen anterior to the heart. The pericardium was exceptionally well seen using 1 mm HRCT slices and we suggest that this may be the optimal technique for visualization of the pericardium. CONCLUSION: The upper limit of the thinnest portion of the normal pericardium (mean + two × standard deviation) is 1.2 mm (10 mm CT slices) and 0.7 mm (1 mm HRCT slices) using modern CT equipment. These values are substantially lower than those previously reported and are in line with anatomical findings.

0810

Pulmonary arterial hypertension and associated pericardial effusion: a CT study

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PURPOSE: Pericardial effusion is occasionally noticed in patients investigated for pulmonary arterial hypertension. This study aims to determine whether pericardial effusion is found significantly more frequently in patients with raised pulmonary arterial pressure. METHODS AND MATERIALS: The CT of three groups of 15 patients were reviewed. Group 1 had a mild increase in mean pulmonary arterial pressure (MPAP) (19 mmHg < MPAP < 35 mmHg). Group 2 showed a marked increase in MPAP (MPAP > 36 mmHg). Group 3 was a randomly selected control group. For Groups 1 and 2, the mean time interval between CT examination and measurement of pulmonary arterial pressure was 19 days. The CT scans were examined on mediastinal windows at the level of maximum visible pericardial circumference, pericardial thickness was measured at five points (a thickness of >3 mm was taken as abnormal). The three groups of patients comprised primary vascular disease ($n=5$), restrictive pulmonary disease ($n=16$), obstructive pulmonary disease ($n=17$) and other disease ($n=7$). RESULTS: Pericardial effusion was seen in 1/15 patients in control group, 1/15 patients with a mild increase of MPAP, and 8/15 (53%) of patients with marked increase of MPAP. On multivariate analysis, the relationship with MPAP was independent of the underlying condition. CONCLUSION: Raised MPAP is significantly associated with pericardial effusion, irrespective of the cause of pulmonary arterial hypertension, however, the pathophysiological explanation for this association is unclear.

0820

Efficacy and safety of MultiHance (Gd-BOPTA/DIMEG) for MRI of acute myocardial infarction

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PURPOSE: To determine the efficacy and safety of MultiHance (Gd-BOPTA/Dimeg, Bracco SpA, Italy) for detection and delineation of acute myocardial infarction (MI) in perfusion MRI. METHODS: A total of 103 patients underwent MRI with a 1.0 T imager 2–6 days after admission with acute MI. T_1SE images were obtained prior to contrast medium administration. T_1, cine and dynamic gradient echo sequences of the myocardium were obtained after iv infusion of 0.05 mmol kg^{-1} MultiHance. A ^{201}TL SPECT examination and a quantitative echocardiogram were also performed on each patient. All information was reviewed by clinicians managing the patients, as well as by two independent assessors. Safety was assessed prior to, immediately after and 24 h after MRI, in terms of medical history and examination, ECG, haematology and clinical chemistry. RESULTS: In 83/103 (80.6%) patients perfusion MRI was adjudged to have provided additional useful information when compared with non-enhanced MRI sequences. Perfusion MRI provided additional information to the ECG in 33.0% of patients, to thallium imaging in 15.5%, to echocardiography in 42.7% and to cardiac enzymes in 3.9% of patients. As regards safety, two serious adverse events were reported by one patient (0.97%) in this study, but these were considered to be unrelated to the administration of MultiHance. Of the non-serious adverse events reported, 92.8% were mild in intensity and the remainder moderate. CONCLUSIONS: We conclude that MRI myocardial perfusion imaging with MultiHance is safe and provides additional clinical information in patients with acute MI.

0830

ECG-triggered image acquisition on a sub-second CT system

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INTRODUCTION: This paper describes the implementation of ECG-triggered acquisition on a sub-second CT scanner and demonstrates the improvement in image quality of cardiac images. Using partial scan reconstruction, with a 0.75 s rotation time, a scan

duration of 0.5 s can be achieved. This duration is sufficiently short to acquire all image data during the quiet phase of the cardiac cycle. MATERIALS AND METHODS: Acquisition is performed on a Siemens Somatom 4 Plus scanner, modified to await a trigger signal before beginning acquisition. ECG signals are digitized and displayed on a personal computer, the R-wave is automatically identified and a trigger delay can be entered interactively. Scan set-up is performed normally on the CT console, with partial reconstruction options selected. When the scan is performed the gantry rotation will commence, but the X-ray beam and acquisition will not start until the trigger signal is received from the personal computer. Reconstruction then continues as for normal scans. RESULTS: Minimum scan repetition time is 0.8 s without table motion and 1.5 s with table motion. In practice, it is possible to image every heart-beat without movement for a normal (60–70 bpm) heart-rate and every second heart beat for images with table movement. The authors will demonstrate the improvement to images of coronary calcification, HRCT of the lung and cardiac anatomy.

0840

Comparison of myocardial SPECT imaging with left arm up *vs* down

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PURPOSE: Conventional myocardial SPECT imaging is performed with the left arm over the patient's head, minimizing tissue attenuation over the heart. This allows the camera to rotate closer to the patient. Many patients cannot lie motionless in this position, which creates motion artefacts. We compared imaging with left arm down *vs* arm up using a coincidence imaging attenuation correction algorithm. We evaluated whether motion artefact was reduced, due to more comfortable patient positioning and if interpretation of the scan significantly differed when comparing these methods. METHOD: During routine $^{99}Tc^{m}$ Sestamibi SPECT rest and stress scans, 14 patients had an extra set of images acquired with the left arm down. This was done either for the rest, stress, or both sets of acquisitions. Each set of images was scored semi-quantitatively by two physicians. A quantitative motion artefact measurement, using amount of pixel-shift, was performed with each set of SPECT scans. A qualitative measurement of patient comfort was obtained. RESULTS: Total number of myocardial segments = 126 each for arm up and down. Number of segments agreed: arm up 84; arm down, 92. Number of segments disagreed: arm up, 42; arm down, 36. All patients agreed that the arms down position was much more comfortable. No significant motion difference was noticed in this group of patients. The differences in scan interpretations was not statistically significantly different when comparing the two methods. CONCLUSION: Arm down imaging appears not to compromise scan quality. This was the method preferred by patients.

0800–0900
Scientific Session
Audit and Management
Hall 11b

0800

General practitioner upper abdominal ultrasound requests: effect on management, referral patterns and clinical outcome

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Most radiology departments offer direct access, upper abdominal, US scanning (USS) to general practitioners (GPs). PURPOSE: We followed up these patients in the community to examine the influence of the scan results on subsequent management and clinical outcome. METHOD: All patients referred for primary upper abdominal USS from a single Birmingham GP practice of 10 000 patients, between 1991 and 1996 were retrospectively reviewed. The USS request, report, GP clinical notes and hospital correspondence were studied for all patients ($n = 82$). RESULTS: The follow-up period from USS was on average 27.9 months [standard deviation (SD) 18.2 months]. 79/82 referrals complied with published guidelines. They were generally supported by adequate, documented, clinical assessment. 77/82 referrals were for suspected gallstone disease. 23/82 (28%) patients had clinically relevant positive findings. Of the positive scans, 18/23 were subsequently referred to the hospital outpatients (OP); 16 had gallstones. Of those with gallstones, 15 underwent cholecystectomy, of whom 12 had no further upper abdominal symptoms. Of the 59 negative scans, eight cases (14%) were subsequently referred to OP. In only 2/8 of these cases was treatment changed as a result of OP review and investigation. The remaining 51/59 were given clinical diagnoses. The majority of these (28/51) had self-limiting symptoms which required minor or no treatment. CONCLUSION: In the practice studied, direct access upper abdominal USS is considerably reducing OP referrals from GPs. Positive scans are generally followed by focused referral of patients to secondary care services, with good clinical outcome.

0810

Peripatetic radiographer-based US service: an audit

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We present the result of an audit of a 12 month study of a comprehensive radiography-based US service (RBUS) in four rural group practices. The audit provides a sample of 550 patients scanned by the radiographers in the group practices and 100 scans effected in hospital using a high resolution US machine, over a period of 12 months, for an array of medical conditions. In all instances the radiographers were responsible for writing reports and making first-line decisions, in consultation with the general practitioners (GPs) and with additional responsibilities for making appropriate referrals to the consultant radiologists for second and higher opinion. The community US service results were compared with the hospital scan results to determine the accuracy of RBUS. Of the 550 patients scanned in the group practices, 395 (72%) patients were saved referrals to the hospital; 155 (28%) abnormalities were diagnosed; and 13 (8%) were referred to radiologists for a second opinion. In 82 cases (55%) scans had a major effect on patient care. The study clearly demonstrates the feasibility and efficacy of a controlled RBUS in the community delivered under the auspices of the local radiology department. The RBUS provides a quick, accurate and valuable aid to diagnosis in group practices and allows immediate availability of results. It saves some hospital referrals and makes other referrals more appropriate, resulting in more efficient patient care.

0820

Metformin and contrast media: a dangerous combination?

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To avoid the rare complication of lactic acidosis, it is currently suggested, both by the pharmaceutical industry and the Royal College of Radiologists, that metformin should be stopped 2 days before and after the use of contrast. Renal function is recommended to be checked prior to the resumption of the drug. It is accepted that metformin should be stopped in intercurrent illness and in renal failure to avoid lactic acidosis. However, lactic acidosis in patients taking metformin with no contraindications or use of contrast have also sporadically been reported. PURPOSE: This study examines the evidence for the recent Royal College of Radiologist's guidelines for use of contrast agents in patients on metformin, to avoid the risk of lactic acidosis. METHOD: A literature review was undertaken using the search agent Medline and the key terms "metformin", "iv contrast agent", "lactic acidosis", "biguanides" and "renal failure". Authors of reports, manufacturers of metformin and the Drugs Information Service were also contacted. RESULTS: 16 cases in total were found. Only one had no contraindication to metformin and developed lactic acidosis after contrast use. The difficulties of searching for reports of a rare reaction are discussed. CONCLUSION: It is suggested that if metformin is correctly prescribed, the risks of lactic acidosis in association with contrast are minimal and have been overstated.

0830

Comparison of imaging and post-mortem reports—a valuable method of audit and error detection

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Departments of Imaging and Histopathology, The Whittington Hospital NHS Trust, Highgate Hill, London N19 5NF, UK

PURPOSE: To assess the accuracy of radiological reports by direct comparison with pathological findings at post-mortem. METHOD: Imaging data were reviewed for all patients in whom post-mortems

were performed during 1996/97. Those included had reported investigations in the months preceding death. Direct comparison was made between pathological and imaging reports to assess degree of concordance. RESULTS: Of the total investigations performed, 69% were found to correlate exactly, 17% showed no correlation and in 14% the site of pathology was correctly identified, but the cause of abnormality was not raised in the differential diagnosis. Pulmonary embolism/infarct as a cause of chest X-ray shadowing accounted for 50% of the latter. Bowel ischaemia, lymphoma and retroperitoneal haemorrhage represent other pathologies incorrectly diagnosed. US gave fewer errors of detection than plain film or CT scan of the abdomen. CONCLUSION: Comparison of post-mortem findings with pre-mortal imaging reports is an important mechanism for feedback and detection of errors. Correlation is helpful in raising the awareness of the reporting radiologist to common, potentially life-threatening conditions, not otherwise considered.

0840
Providing a high quality MRI and CT scanning service: what the users think
T Grajewski and S Moss
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MRI and CT scanning have traditionally been considered expensive diagnostic modalities. There has been discussion about the most efficient ways of providing these services. In order to further inform this debate, an in-depth appraisal of scanning services at five different sites within the UK has been undertaken as part of a larger investigation, funded by the European Commission. The sites have included a university teaching hospital, a major inner-city general hospital, a large rural hospital and a small general hospital. The study has involved both qualitative and quantitative methodologies. The initial finding relating to the perception of out-patients and referring clinicians (consultant medical staff and specialist trainees), as obtained through questionnaires, are described here. Response rates for patients varied between 70% and 92%. Significant differences between sites were found, particularly relating to: the patient's satisfaction with the waiting for an appointment; the delay in receiving results; and their perception of treatment by staff. Response rates for clinicians were lower and varied between 40% and 47%. However, this was considered a good response for the extensive nature of the questionnaire and signified a high degree of interest. Differences were noted in relation to working practices including: frequency of discussions of scans with radiology colleagues; quality of service provided; and the overall rating of MRI and CT services. Many aspects of service quality were found to be inversely related to the overall workload of the department and the organization of the scanning service.

0850
Departmental accreditation
E P H Torrie
Royal Berkshire Hospital, London Rd, Reading RG1 5AN, UK
To promote and maintain standards of radiology training, teaching departments undergo a formal process of accreditation. This is supervized by the Training Accreditation Committee which, in turn, reports to the Education Committee at the College. This is purely educational and does not address the problem of setting standards of the day-to-day delivery of patient care. The Royal College of Radiologists has commissioned a working party whose terms of reference are to set basic accreditation standards and advise on their implementation. The working party assessed the accreditation systems currently available and came to the conclusion that these were either too prescriptive, or mainly an exercise in box ticking. The Working Party has come up with a philosophy and methodology which we feel is more meaningful and helpful and therefore more likely to be enthusiastically endorsed. The key features are: (i) the system is PC based; (ii) a hub-and-spoke principle of information sharing and common development of standards and services; (iii) provision of competent standards set with a fully maintained data-base of statutory, legislative and profession guidance documents; (iv) anonomized bench-marking for all information shared. The cyclical process of this PC-based accreditation tool will build up a portfolio of national standards, self-set standards and goals, helping individual services to identify those which have been surpassed and those which remain aspirational. The Royal College of Radiologists is currently funding this project, which will lead to a fully developed PC-model which, in turn, will be piloted nationally.

0815–0845
Keynote Lecture
Gamma Knife Practice
Hall 10b

0815
Invited Review
Gamma knife stereotactic radiosurgery—equipment considerations
L Walton
National Centre for Stereotactic Radiosurgery, Royal Hallamshire Hospital, Sheffield S10 2JF, UK
The "Gamma knife" was designed for stereotactic radiosurgery by a neurosurgeon, Professor Leksell, who performed the first treatment using it in Stockholm in 1968. A unit was installed in Weston Park Hospital Sheffield in September 1985 and it became the third gamma knife in clinical operation. Worldwide, there are now around 100 gamma knives. The knife has 201 individual ^{60}Co sources arranged in a hemispherical array. Each source produces a finely collimated beam which is directed towards a common focus. The combination of all 201 beams results in a focus of high dose, with a rapid fall-off with distance. The size of the irradiated volume at the focus is determined by the divergent aperture in the secondary collimators, four collimator sizes, 4, 8, 14, and 18 mm, being available. The volume within the 50% isocontour is considered to be the treatment volume and is roughly "egg" shaped. These volumes can be used individually, or in any combination of overlapping focii, to produce a larger and/or complex shape. Typically, a treatment plan would use 5–15 overlapping fields to produce a conformal dose volume. Effective treatment requires accurate localization of the lesion and accurate positioning for subsequent treatment. This is achieved using a rigidly fixed stereotactic frame. A radiological investigation (usually MRI for tumours or angiography for vascular lesions) is performed with the frame attached. The treatment is delivered later the same day. To date, around 2800 lesions have been treated with 8500 gamma knife focii.

0900–1045
State of the Art Symposium
Aortic Dissection—The Diagnosis
Hall 1

0900
Invited Review
The case for CT
A A Nicholson
Department of Radiology, Hull Royal Infirmary, Hull HU3 2JZ, UK
There are a number of imaging modalities available to the clinician for the diagnosis of aortic dissection. These include: invasive methods, such as angiography; semi-invasive methods, such as transoesophageal (TOE); and non-invasive methods, including CT and MRI. The latter three techniques are highly sensitive and specific for aortic dissection. In this presentation the advantages of CT over angiography, TOE and MRI, will be described.

0920
Invited Review
The case for MRI
I W Brown
Department of Cardiothoracic Radiology, Southampton General Hospital, Southampton SO16 6YD, UK
This presentation will examine the role of MRI in imaging the patient with a diagnosis of acute dissection. Stress will be particularly laid on the detailed and exquisite anatomy available from the study. It will demonstrate the importance of the findings, both for making the diagnosis and excluding other possibilities in the patient with putative dissection; deciding on the relevance or otherwise, of immediate surgery and helping decide on the preferred surgical option. The findings also provide important prognostic information regarding likely medium and long term outcome. The presentation will lay particular stress on the ability of MRI to provide information regarding luminal anatomy, processes occurring in the aortic

wall and changes associated with dissection which occur both in the mediastinum and each pleural cavity. The presentation will also show the importance of demonstrating mural haematoma as a preliminary stage in the evolution of aortic dissection.

0940
Invited Review
Angiography in aortic dissection
P Gishen
Department of Clinical Radiology and Nuclear Medicine, King's Healthcare NHS Trust, London SE5 9RS, UK
The role of angiography in aortic dissection has decreased during the past decade due to the development of CT and, latterly, spiral CT, MRI and US, including endoscopic US. There is still a role for angiography, particularly in the light of the development of aortic stenting.

1000
Invited Review
Aortic dissection—the case for echocardiography
D F Ettles
Department of Radiology, Hull Royal Infirmary, Hull HU3 2JZ, UK
Echocardiography offers important advantages over other imaging methods in assessment and management of suspected aortic dissection. Imaging and Doppler modalities provide a unique combination of structural and functional information about the aorta and heart. As the equipment is portable, transthoracic and transoesophageal (TOE) studies can be performed in the admission unit or in intensive care, where full monitoring and clinical back-up is available. Echocardiography is inexpensive and avoids the use of ionizing radiation and contrast media. Rapid diagnosis is possible and sequential bedside studies can be performed to monitor progress and therapy. The proximal ascending aorta can be imaged in most patients by transthoracic echo, detection of an intimal flap obviates the need for other investigation. Pre-operative assessment of left ventricular function can be made and aortic regurgitation detected and quantified. Pericardial fluid or tamponade is easily assessed and a complete examination of other cardiac structures undertaken. When the transthoracic study is inconclusive or negative, despite a high index of suspicion, a TOE study can be performed without the need to move a potentially unstable patient. TOE performed under iv sedation can be completed in a few minutes with minimal risk. Multiplane TOE allows cross-sectional and longitudinal imaging of the thoracic aorta with excellent sensitivity and specificity for aortic dissection. The relationship of any dissection flap to the coronary vessels and arch branches can be demonstrated. Colour flow mapping helps to determine entry site, differentiate false and true lumen and show sites of fenestration. Excellent visualization of the other cardiac structures is possible by TOE. Intraoperatively, TOE allows confirmation of ventricular performance before bypass is discontinued, and verification of aortic valve resuspension and competence. TOE follow-up in chronic dissection is used to confirm thrombosis within the false channel and detect further aortic dilatation.

1020
Discussion

0900–1000
Keynote Lectures
Forensic Radiography
Hall 9

0900
Invited Review
Mass grave investigations
B Tonello
Alex Wing X-ray, The Royal London Hospital, London, UK
Following the war in the former Yugoslavia, many mass graves were located. This presentation is about the experiences of a radiographer in the multidisciplinary team assembled to carry out the forensic investigation of one such grave. The role of radiography at each stage, from initial introduction to the mortuary, through the investigative process to the final identification of bodies, will be explored.

0930
Invited Review
The role of forensic radiography in a disaster investigation
[1]M D Viner, [2]M Cassidy and [3]V Treu
[1]*Diagnostic Imaging Department, Royal London Hospital;* [2]*Department of Forensic Medicine and Science, University of Glasgow, UK; and* [3]*Eindhoven Police Force, The Netherlands*
PURPOSE: To define and discuss the role of radiography in the forensic investigation of disasters and the identification of victims. BACKGROUND: In September 1997, a United Nations Helicopter crashed in central Bosnia in a remote valley 25 km from Sarajevo. A forensic pathology team working for the UN International Criminal Tribunal for the former Yugoslavia in the vicinity were asked to assist in the forensic investigation of the incident, by examination of the remains of the disaster victims, to determine (i) the cause of death and (ii) establish positive identification. RESULTS: Positive identification was established on all 12 victims of the disaster, four by dental records, six by DNA and two by finger-printing. Fluoroscopy was used to chart the remaining body parts and to locate and identify metallic artefacts. Dental and other plain film radiographs were used for comparison with medical records to establish positive identification. CONCLUSION: This presentation discusses the role of radiography in the forensic investigation of disasters, making comparison with other disaster investigations in the UK and Europe. It will also address the issue of the need for appropriate training for forensic radiography and the potential for establishing specialist forensic teams with appropriate available equipment for disaster investigation.

0900–1045
State of the Art Symposium
Interaction of Imaging and Brachytherapy
Hall 10b

0900
Invited Review
Towards conformal brachytherapy
B Jones
Consultant in Clinical Oncology and Senior Clinical Research Fellow, Clatterbridge Centre for Oncology and University of Liverpool, Wirral L63 4JY, UK
Brachytherapy was probably the first form of conformal radiotherapy. Pioneer techniques attempted to surround a tumour with radium. More sophisticated rules for source placement, source strength and treatment duration were later developed. Brachytherapy, like teletherapy, has also developed in the modern era: remote control after-loading, computer planning, small high intensity sources and several different patterns of dose delivery (CLDR, HDR and PDR). The advent of true 3D planning will provide challenges for the improvement of both brachytherapy and teletherapy. By increasing the conformity of treatment, tumour control can theoretically be enhanced by the use of higher tumour doses. Normal tissue can be protected by careful attention to normal tissue doses and volumes. In brachytherapy, there are five sequential optimization procedures which should be fulfilled to achieve the best therapeutic ratio. (i) Intraoperative and image-guided catheter placement to provide the basis of good treatment geometry and normal tissue dose estimation. (ii) Source positioning (relative to tumour and normal tissue). (iii) Source dwell time optimization (to produce the physical dose) which best conforms to the tumour. (iv) Optimization of dose rate (in low dose rate brachytherapy) and the dose per fraction and mean interfraction interval (for high dose rate brachytherapy) depending upon how long the catheter(s) can remain in place. (v) Optimized scheduling of brachytherapy relative to teletherapy and other treatment modalities, such as surgery or cytotoxic chemotherapy. Thus, the optimization process simultaneously aims to reduce normal tissue morbidity and increase tumour control by isodose conformity with tumour geometry and non-conformity with normal tissue. These sequential optimization procedures are being pursued by the use of brachytherapy as a boost in the gynaecological cancers and in the attempted radical treatment of gliomas. Examples of the application of these concepts in clinical practice will be provided.

0930
Invited Review
Routine imaging during brachytherapy
P J Hoskin
Marie Curie Research Wing, Mount Vernon Hospital Rickmansworth Road, Northwood HA6 2RN, UK
Imaging in brachytherapy is important both to verify applicator position and to define dose distribution to the target volume and surrounding normal tissue. Orthogonal X-rays are limited in defining soft tissue structures around the applicators. CT scanning can identify accurate positioning of sources within normal tissue structures, but many metal applicators cause artefact on the images reducing their accuracy and definition. US may overcome this problem and in prostate brachytherapy provides the optimal imaging method, both for defining the position of applicators placed transperincally into the prostate gland and using sequential images to build up a 3D image and define the prostatic target volume. Whilst accurate definition of implant geometry and its relation to normal tissue structures can be achieved at the time of insertion, it is also important to consider changes which may occur during the brachytherapy procedures. Considerable changes can arise in the pelvic area, affecting gynaecological, prostatic and rectal brachytherapy, due to variations in bladder volume. The impact of bladder volume upon dosimetry from vaginal vault irradiation has been evaluated using CT scanning with different bladder volumes. A significant reduction in small bowel dose is seen as the bladder rises with increasing volume, but the maximum bladder dose also increases by a mean of 1.5 Gy for a prescribed dose of 5.5 Gy at 5 mm depth from the vaginal mucosa when an empty bladder is compared with that containing 100 ml. It is important that considerations of variations in anatomical structures are taken into account during implantation and brachytherapy treatment when defining the conditions for brachytherapy and tolerance doses.

1000
Invited Review
Imaging during radiotherapy and brachytherapy for cervical carcinoma
L T Tan
Oncology Centre, Addenbrooke's NHS Trust, Cambridge CB2 2QQ, UK
Radical radiotherapy for cervical carcinoma usually involves initial external beam radiotherapy (EBRT) to the pelvis followed by intracavitary brachytherapy (BT) to boost the dose to the primary tumour. Imaging is required at various stages throughout the planning and treatment process. (i) *Tumour assessment and staging* Conventional assessment of tumour size and stage involves examination under general anaesthesia and imaging with X-ray CT. However, MRI has been shown to be superior to CT in the assessment of tumour volume and spread, due to its high tissue contrast and multiplanar imaging capability. (ii) *EBRT planning* EBRT treatment is usually planned by reference to bony landmarks on orthogonal radiographs. This can result in geographical miss of the primary tumour, particularly if a four-field technique is used and/or there is involvement of the utero-sacral ligaments. The risk of geographical miss can be reduced in several ways, *e.g.* by modifying the radiotherapy technique or by CT planning. (iii) *BT treatment* Orthogonal radiographs are obtained during BT treatment for the purpose of dose calculation and normal tissue dose estimation. The estimation of maximum rectal doses from orthogonal radiographs has been shown to be reasonably reliable, with good correlation with the risk of rectal complications. In contrast, bladder dose estimation from orthogonal radiographs is unreliable, particularly for triple source treatments and more precise methods of dose estimation, using CT or ultrasonography, may be required. For single line source systems, bladder dose estimation from orthogonal radiographs has been shown to be more reliable, due to the radial symmetry of the isodose distribution. (iv) *Assessment of tumour response* The rate of tumour regression during EBRT can be reliably estimated using serial MRI. This may have the potential to detect the subset of patients who may benefit from more intensive treatment.

1020
Invited Review
How can serial imaging improve the results of brachytherapy?
R G Dale, B Jones, I P Coles and L T Tan
Department of Radiation Physics and Radiobiology, Hammersmith Hospitals NHS Trust, London W6 8RF, UK
All types of brachytherapy are dominated by the special restrictions imposed by the inverse-square law, which ensures that small changes to the geometrical juxtapositioning of the applicators and tissues will usually have significant dosimetric and radiobiological consequences, which may affect the clinical outcome. Post-implant images obtained at the start of treatment enable an assessment to be made of the extent to which a particular application deviates from that ideally required, but they take no account of any later dynamic changes. Serial imaging of the application during the period of treatment can provide a useful indicator as to when intervention may be required, *e.g.* to alter the overall treatment time, or to modify the originally prescribed arrangement of source positions and dwell times. Even in cases where the geometrical positions of the sources/applicators remain relatively unchanged as treatment progresses, there may be movement of the tumour and normal tissue boundaries resulting from shrinkage and/or oedema. Regular serial imaging of specific sites can provide data on how tissue volumes change with time into treatment; such results may be used to develop a more realistic appreciation of how best to plan and assess brachytherapy treatments.

0900–1000
Scientific Session
*info*RAD™ 5—IT Integration into the Healthcare Environment
Hall 11a

0900
Invited Review
Integrating imaging systems: why, how and if
D L Plummer
Department of Medical Physics & Bioengineering, UCL Hospitals, London WC1E 6JA, UK
There is a wide diversity of computer systems in clinical imaging services. These include: RIS (possibly more than one); hospital wide data sources (PAS etc.); imaging devices and workstations; image archive systems; film tracking systems; patient record tracking systems. There is little argument that it would be desirable to integrate these data sources so that their content can be accessed in a uniform and consistent manner. The question is how this might be achieved and which solutions are appropriate under which circumstances. At one extreme, it may seem appropriate to provide all services with a single unified system. This (let us call it the Integrated System approach) promises the highest degree of integration. At the other pole one might seek to provide interfaces between systems so that data communication and sharing is possible. This (which we might call the Interface Engine approach) could offer maximum flexibility. In between are approaches such as Data Warehousing where information from multiple sources is integrated for retrieval and analysis purposes, but interactive systems remain discrete. A standards based approach can offer a structured way forward. DICOM, HL7 and other open interface standards can be used to achieve both connectivity and flexibility, whilst legacy systems can interface via gateways. This route is proposed as the most likely to achieve a stable cost effective solution.

0930
Quality assurance on a network
P Clark
Mid-Kent Oncology Department, Maidstone Hospital, ME16 9QQ, UK
The Mid-Kent Oncology Centre at Maidstone Hospital, Kent, opened in April 1993. It replaced the existing centres at St William's Hospital, Rochester and Pembury Hospital, Kent. The centre is networked with its own management system ORTIS. In 1995, the centre began working towards ISO 9002, reviewing all the protocols that were in place and converting them onto an on-line documentation system. The aim is to improve access to, and control of, documents in the quality management system. Documentation control is under development and uses a Unix operating system. It provides documentation using HTML format and Web browser software. Documents appear as intranet pages. The advantages of this include: immediate and simple document version updates; multiple access to documents whilst reviewing them; feedback to author via email, this makes the contact process two-way; easy numbering and librarianship; access control and encryption with PGP (pretty good privacy); and electronic signatures providing authorization of documents. Other advantages include: information is available to

everyone; access levels are defined by passwords; read-only facilities enable access to all users. Further developments include linking the documents to integrated care pathways, which can also be linked to the on-screen request form. CONCLUSIONS: Intranet provision creates overall improvements in quality of information, and staff, costing and patient-held information.

0940
Discussion

0900–1100
Workshop
How to Specify and Choose Imaging Equipment
Olympian Suite

0900
Invited Review
What's in a specification?
C P Lawinski
KCARE, King's College Hospital (Dulwich) London SE22 8PT, UK
Every year many millions of pounds are spent in the NHS on diagnostic imaging equipment. Selection can be difficult, with an increasing number of suppliers and manufacturers offering a wide variety of packages which can vary significantly in specification and cost. Making the right choice can be very difficult and a wide range of factors must be considered. It is important for the purchaser to gain enough information from each supplier to make the correct final decision. Many areas must be addressed, including clinical requirements, safety, technical performance, service and cost. Currently, many NHS establishments have their own specification questionnaires. Thus, the suppliers must provide answers to a different series of questions in each case. One approach, which should prove popular with the suppliers, would be a standard document designed to provide the optimum amount of information to the purchaser. Currently, the Device Technology and Safety section of the Medical Devices Agency in conjunction with KCARE (King's Centre for the Assessment of Radiological Equipment) is piloting a standardized specification system. A software package will provide series of questions designed to cover all categories of general diagnostic X-ray equipment. An additional feature will allow replies from each supplier to be entered into a spreadsheet for easy comparison. It is intended that the service will be available free to NHS establishments. Another new service from KCARE is to provide up-to-date evaluation data, which will eventually cover all radiological systems offered in the UK. Individual files are maintained for each product, providing a full overview of the UK equipment market. Product comparison reports are regularly published in *Diagnostic Imaging Review*. These provide a clear comparison of systems of a particular category and address issues relevant to selection and purchase. MAGNET already provides a comprehensive specification document for MRI equipment, which is available at a nominal cost. IMPACT provide a similar service for CT systems. Both centres also publish evaluation reports on a regular basis. In summary, it is hoped that a unified approach to equipment specification will simplify the selection and purchase of diagnostic X-ray equipment.

0915
Invited Review
Do evaluations really help?
J P De Wilde
Department of Electrical Engineering, Imperial College, London SW7 2BT, UK
PURPOSE: This paper will look at the task of evaluating medical imaging equipment and examine the usefulness of the information gathered. The Medical Devices Agency and its predecessors have been funding evaluations of medical imaging equipment since 1979. The data gathered from these evaluations have been used for several purposes. They can be compared for intersystem comparison during specification of equipment and during purchasing decisions. They can also be used on single systems for acceptance testing and daily or monthly quality assurance. METHODS: Evaluation of medical equipment ranges from a 2 day intensive scanning session to a 6 month in-depth analysis. In general, for the technical evaluation, test objects are scanned and data are derived from the analysis of these images. In CT and X-ray, safety information on dose is assessed. On all systems user information on ergonomic factors is gathered. RESULTS: Examples where evaluations have been essential will be discussed; for example, for general X-ray equipment only 40% of evaluated equipment has been found acceptable with no modification or changes. Evaluations of MRI have detected software bugs during type testing and have helped secure replacement of RF coils not working to specification during acceptance testing. CONCLUSION: Evaluations have provided a wide range of information, supplying baselines for comparison and specification. Evaluations help by showing hospitals, manufacturers and suppliers what can and should be expected from each imaging modality.

0930
Invited Review
Can NHS supplies assist?
J T Marshall
NHS Supplies, Purchasing Division, Bristol BS20 0LH, UK
The use of specifications in the purchasing process in the National Health Service (NHS) is widespread. Such specifications are often lengthy, restrictive and of a technical questionnaire nature, and add little value to the purchasing process. They carry relatively low weighting of all the factors which go into one final decision making process which results in a choice of imaging equipment. The presentation will illustrate how specifications can be confusing for both the equipment user and the supplier, and will suggest ways in which a more realistic approach to deciding which model of equipment represents best value for money.

0945
Invited Review
Does the manufacturer have a view?
B G White
Medical Engineering, Siemens PLC, Siemens House, Oldbury, Bracknell RG12 8FZ, UK
The provision of a high quality radiological imaging service necessitates the purchase of high quality equipment, which is provided to clearly defined, clinically-specified requirements. Since the change in purchasing procedures during the late 1970s, manufacturers have received a wide variety of "quasi" specification documents accompanying tenders, often with indefinite requirements. It became apparent that Trusts seeking to procure equipment were producing documentation which sometimes failed to achieve the objective of satisfying clinical needs in the provision of a quality patient care service. Examples of such tender specifications have included a variety of approaches, ranging from questionnaires on what is available, to the impossible extreme of specifying all desirable features, selected from many different brands in one imaging system. Manufacturers have often faced the dilemma of having to decide how to best align their equipment against ambiguous specifications, with the result that the adjudication process has not always compared "like with like". This paper offers an industry-view of current practice, takes a discreet look at case examples and considers options for the creation of a more suitable form of specification. It is intended that this would enable the manufacturer to offer additional user-related benefits, which will further stimulate competition, and hence benefit purchasing, clinical users and, ultimately, the patient by the better availability of superior imaging equipment.

1000
Invited Review
What's the end result clinically?
E J Loveday
Radiology Department, Southmead Hospital, Westbury on Trym, Bristol BS10 5NB, UK
We have recently tendered for and purchased new CT equipment using the NHS Supplies "restricted procurement" procedure. This presentation will briefly outline the procedure, detailing the strengths and weaknesses of the method, and demonstrate how going through the process resulted in a solution meeting our needs. In an area where the technical issues are complex, it is important to define the key issues relating to an individual purchase. These include the budget, timescale, operational requirements and user parameters. The presentation will focus upon how the latter two were used to arrive at a purchasing decision and to what degree our expectations were fulfilled.

1015
Invited Review
What does the customer really want?
P J Richardson
Department of Clinical Radiology, United Bristol Healthcare Trust, Bristol BS2 8HW, UK
A satisfied customer receives their equipment on time, to a prepared site, within an agreed installation window, to the defined standard, with a minimum of disruption and without any unforeseen costs. Circumstances define the level of satisfaction, not necessarily equipment performance! The presentation will focus on management issues which drive equipment procurement at a time of continual change within the NHS.

1030
Discussion

0915–1040
Scientific Session
Management and Education
Hall 11b

0915
Invited Review
Specific features of radiological management in Russia
A Vasilyev
Central Military Scientific Research Aviation Hospital, Moscow 107014, Russia
Over the last decade Russia has begun to adopt European principles when constructing and managing its radiology departments. An analysis of the current system of providing radiological aid has been made with regard to specific factors characteristic of countries which formerly comprised the USSR. One such factor is the lack of qualified financial management in radiology departments which can mean, for example, that while medical devices produced by various manufacturers are purchased for one division, equipment necessary to other divisions in the department, which would ideally be produced by the same manufacturers, cannot be provided. Other factors studied include: (1) the high enthusiasm and motivation of physicians for continuing medical education; (2) the increased integration of the radiological professions; (3) the varying modernity of equipment in different radiology departments, some employing X-ray equipment which has been in use for over 20 years while others use the most sophisticated diagnostic equipment available; (4) the lack of consideration by foreign manufacturers for the level of service Russian radiology departments are trying to provide, for example, the delivery of parts for computed tomography equipment has been known to take over a month; (5) the poor dissemination of up-to-date radiological information to remote areas; and (6) the lack of sufficient experience of radiological professionals in medical management. An analysis of the results obtained from studying these factors indicates the necessity for the development and prompt application of improved management in Russian radiology departments.

0940
What training do gastroenterologists want in abdominal US? Results of a national survey of trainees
[1]E R E Denton, [2]C P Jamieson and [3]W R Burnham
[1]*Department of Radiology, Guy's Hospital;* [2]*Department of Gastroenterology Royal London Hospital; and* [3]*Department of Gastroenterology, Oldchurch Hospital, London, UK*
PURPOSE: To establish whether gastroenterologists wish to train in abdominal US according to the recommendations of the Royal College of Radiologists' document *Guidance for the Training in Ultrasound of Medical Non-radiologists*. To determine if the US case-mix referred by gastroenterologists differs from that of other clinicians. METHODS: A postal questionnaire was sent to all 278 gastroenterology trainees. Comparison of the indications and findings of 100 consecutive gastroenterologist-requested abdominal US scans with 100 scans sequentially requested by other clinicians through the same teaching hospital radiology department. RESULTS: 78% of survey forms were returned. 77% of trainees wished to train in abdominal US and 68% were prepared to train in the manner detailed in the guideline document. However, 86% felt that they would ideally prefer not to assess renal or pelvic pathology, restricting themselves to hepatobiliary diagnosis only. 82% of trainees did not normally expect a further scan by a radiologist to be required. Comparison of gastroenterology scans with those requested by other clinicians revealed a relative excess of hepatobiliary indications and findings, and a marked paucity of renal and pelvic pathology in gastroenterology practise. CONCLUSION: There is general interest in abdominal US training amongst gastroenterology trainees and a broad acceptance of the guideline document. However, most trainees perceive a focus of training restricted to hepatobiliary diagnosis to be most appropriate. The case-mix study provides some support for this viewpoint, though whether a limited training provides an optimum service to patients requires debate.

0950
Collaborative learning in the radiology department
C B Smith, J Kirtley, N Pearman and S Goodwin
School of Radiography, University of Derby, Devonshire House, Derbyshire Royal Infirmary, London Road, Derby DE1 2QY, UK
The authors will present findings of a study trip to the University of Alabama, Birmingham, USA undertaken in February 1998. This trip was supported by the Trent Health Quality Travel Award 1997, established in recognition that collaboration between staff of all disciplines is to be encouraged when seeking quality improvement. Following this theme of working together, a team composed of two radiographers (from Leicester General Hospital NHS Trust and Leicester Royal Infirmary NHS Trust), one radiology manager (Leicester Royal Infirmary NHS Trust) and one lecturer (University of Derby) visited the University of Alabama to explore the integration between clinical practitioners and academic institution throughout the education of radiographers, at both undergraduate and postgraduate level. The team members were seeking innovations in education that could be used during student radiographers' clinical placements and exploring the ways in which academic staff, clinical practitioners and students work together to enhance the educational experience for all parties. The presentation will focus on two areas that are consistent with the objectives of the study: strategies by which clinical staff are able to facilitate student radiographers' education during clinical placements, and methods by which integration of academic institution and clinical sites is achieved.

1000
Setting standards of practice in radiology departments: the radiographer's role
A Fryszczyn, R Greaves and D Nag
Department of Radiology, Barnsley District General Hospital NHS Trust, Barnsley S75 2EP, UK
PURPOSE: To establish whether radiographers can make a contribution towards setting and implementing standards in a radiology department. PATIENTS AND METHODS: Over a 2 year period, evidence of current practice was collected and documented in two areas: (i) essential clinical details on request cards for cranial CT in patients with strokes; and (ii) skull X-rays preceeding requests for cranial CT in patients primarily with suspicion of pituitary disease. Standards of practice were discussed and circulated to clinicians for agreement prior to implementation. RESULTS: The date of onset of strokes was deemed essential on requests, yet only appeared in 20%. The incidence of prior skull X-rays in suspected pituitary disease was 65% over an 18 month period, showing a very low negative predictive value, and were considered inappropriate. After 3 months of circulating new guidelines, reassessment by radiographers showed (i) Date of onset of strokes on request cards appeared in 50%, rising to 70% after a further 3 months. (ii) Only 10% of patients had skull X-rays prior to CT for pituitary disease; even these were for unrelated reasons. CONCLUSION: Radiographers have a valuable contribution to make in the setting and implementation of standards of practice.

1010
Medical imaging: challenges associated with the assessment of study validity in systematic literature reviews
[1]S Kelly, [1]E Berry, [2]P Roderick, [3]K M Harris, [4]P J O'Connor, [5]J Hutton, [4]J Cullingworth, [4]L Gathercole, [6]I Isherwood and [1]M A Smith
Departments of [1]*Medical Physics,* [3]*Clinical Radiology and* [4]*CT/MR, Leeds General Infirmary, LS1 3EX;* [2]*Wessex Institute for Health R&D, Southampton SO16 6YD;* [5]*MEDTAP International Inc, London W1Y 1RL; and* [6]*University of Manchester M13 9PL, UK*
PURPOSE: To evaluate a generic methodology for systematic literature review applied to a specific imaging application. METHODS: The topic addressed was endoscopic US (EUS) for staging gastro-oesophageal cancer. Published studies were identified by searching electronic databases, non-indexed journals and conference abstracts. Studies were judged against topic specific inclusion criteria, before

an assessment of study validity. The methodology required the completion of a checklist designed objectively to identify the presence of a variety of biases which influence study validity. It was also recorded whether sufficient information was reported to allow assessment. RESULTS: In 22 studies of the use of EUS for the preoperative staging of gastro-oesophageal cancer, if lack of information was taken to indicate the likely presence of bias, no study was free from all potential biases. None gave sufficient data to assess patient selection or patient cohort biases; 18 omitted information related to disease progression bias; only two reported blinding of observers to avoid diagnostic review or test review bias; and most demonstrated verification bias. CONCLUSIONS: The majority of the studies contained bias likely to influence the study results. The widespread inadequacy of reporting has two-fold implications for systematic reviews in medical imaging. Firstly, reviewers must perform follow-up work or potentially valid studies will be excluded from review. Secondly, the objectivity of the ranking of study validity is compromised.

1020

The use of a computerized logbook database in radiology training and audit

R Burgul and G Roditi

Department of Radiology, Aberdeen Royal Hospitals NHS Trust, Aberdeen AB25 2ZN, UK

Following the introduction of the Specialist Registrar (SpR) Grade it is now a requirement for all radiology trainees within the UK to keep a log of all procedures and examinations. The Royal College provides a comprehensive logbook organized by body systems, but both data entry and retrieval can be time-consuming. We describe the use and potential for audit of a computerized logbook designed and implemented by registrars in training which has been accepted by the Royal College of Radiologists for use nationally. Data entry to the system is simplified by the extensive use of auto-entry features and menus. Data recorded for each procedure includes level of supervision, trainer, body system, urgency, complications and patient state. In Aberdeen, 10 registrars have recorded over 19 200 procedures over a 16 month period, accurately reflecting in-service training in this Department. Analysis of the data reveals the breadth of exposure to various procedures by registrars in each of the 5 years in training. The proportion of procedures observed, supervised by consultant trainers, supervised by other registrars and unsupervised can be evaluated. This information has already proved invaluable locally in assessment and planning of registrar training. Clinical audit and complication rates can also be assessed with ease. The countrywide use of this database will make it possible to gather accurate information regarding in-training experience throughout the UK. Direct comparisons between departments could also be made. This database would effectively close the educational audit loop following the publication of minimum requirements for SpR training.

1030

Comparing the performance of consultants and trainees in interventional radiology using dose–area product

D Johnson, I Francis, J Young and A Watkinson

Department of Imaging, The Royal Free Hospital, London NW3 2QG, UK

PURPOSE: To define the average and range of dose–area product (DAP) levels for a range of interventional procedures, for both consultants and trainees. This should provide a platform for setting standard target ranges for trainees, which can form the basis of cyclical clinical audit. METHOD: DAP data were obtained from records in one of the interventional suites at the Royal Free Hospital, covering a period of 1 year, 1993–1994. This is a busy unit with a broad spectrum of interventional procedures undertaken. From the data, the mean, range and standard deviation were calculated for both trainees and consultants. Student's t test was used to compare the two groups for each procedure. Standards for the trainees were then set, based on the mean and standard deviation. RESULTS: The data collected involved four consultants and six trainees. There was significant difference in DAP levels (cGy cm^{-2}) involving most of the procedures analysed, down to a level of significance of $p<0.05$, *e.g.* for percutaneous transhepatic cholangiography, trainee range 870–9517, mean = 6385, consultant range 776–8252, mean = 3354, respective standard deviations were 1524 and 1207. The difference was significant down to a level of $p<0.01$. CONCLUSION: Consultants used significantly lower DAP levels than trainees across a broad range of techniques. There is a need to set standards for trainees and the data provides a means for setting target ranges for interventional procedures for trainees (mean ± 2 standard deviations) which in turn can be used for cyclical clinical audit. This should lead to a raising of standards and benefit both the radiologist and the patient under the auspices of ALARA.

1015–1045
Keynote Lecture
CT of Abdominal Trauma
Hall 9

1015

Invited Review

CT of abdominal trauma: diagnostic features and their clinical significance

J A Spencer

St James's University Hospital, Leeds LS9 7TF, UK

In this review the role and examination techniques of CT in the assessment of the multiply-injured patient will be critically assessed. Key diagnostic features of solid and hollow organ trauma and common pitfalls in interpretation will be covered. In recent years there has been a trend towards non-operative management of liver and spleen trauma. Emphasis in CT assessment has shifted from diagnosis of these injuries to their grading and to recognition of features associated with poor outcome. Historically, the accuracy of CT for diagnosis of bowel and pancreatic injury has been disappointing. Conservative management strategies further increase the importance of early CT diagnosis of these injuries. Delayed diagnosis is attended by greatly increased morbidity and mortality. CT features of trauma to the bowel, mesentery and pancreas, and their implications for surgical management, will be covered in detail.

1030–1200
State of the Art Symposium
Guidelines for the Imaging and Management of Metastatic Bone Disease in Breast Cancer
Hall 11a

1030

Invited Review

Bone metastases in breast cancer: why have guidelines?

H M Bishop

George Eliot Hospital NHS Trust, College Street, Nuneaton, UK

In recent years, the breast industry has done much to try and improve the quality of diagnosis and treatment for women with symptomatic breast disease. These benefits have flowed from the creation of a National Breast Screening Programme, which has set quality standards. Although the majority of women are now referred to specialist breast units in the UK and there has been a considerable improvement in the diagnostic process for women at the beginning of their cancer journey, there is doubt as to whether this level of excellence extends to the development of metastatic disease. Women with metastatic disease from breast cancer, particularly bone metastases, may present to a variety of different clinicians in very different specialties. There is often delay in the diagnosis of these bony metastases. There is often inappropriate or non-existent treatment. There is a lack of focus in the care of these patients and pain relief is often poorly dealt with. This paper describes how a group of clinicians from around the UK have tried to improve the quality of care for women with this painful and debilitating condition at the latter end of their cancer journey. The guidelines that are being presented are based on extensive discussion and consultation with all interested parties.

1045

Invited Review

Detection and diagnosis

A M Davies

MRI Centre, Royal Orthopaedic Hospital, Birmingham B31 2AP, UK

Despite improvement, with the national screening programme, in the initial detection and diagnosis of breast cancer, significant numbers of women will subsequently develop bone metastases. Early diagnosis relies heavily on imaging, although education of patients and general practitioners is important to ensure prompt and appropriate referral. The proposed guidelines suggest that women with a history of breast cancer and a clinical presentation suspicious of bone metastases should be referred directly to the Breast Cancer Clinic and preferably not investigated by the general practitioner. It is recognized that the radiograph will remain the initial

investigation of choice, even though it is relatively insensitive. Bone scintigraphy is more sensitive, but routine screening of asymptomatic women in an attempt to diagnose bone metastases early has not been found to be of any benefit. MRI is the most sensitive imaging technique for the demonstration of marrow infiltration. The proposed guidelines indicate how these different techniques should be employed, depending on the level of clinical suspicion of bone metastases. Once a bony abnormality has been detected, there remains the need to confirm that this is a metastasis from breast carcinoma. Diagnostic difficulty usually only occurs with solitary lesions when the simplest course of action may be to perform a bone biopsy.

1110
Invited Review
The radiologist's role in staging and response assessment in advanced breast cancer
A J Evans
Nottingham National Breast Screening Training Unit, Nottingham City Hospital, Nottingham NG5 1PB, UK
Accurate staging of advanced breast cancer (ABC) is important for the following reasons; the sites of spread influences prognosis, soft tissue involvement carries a worse prognosis than bone. This, in turn, affects therapy. Patients with soft tissue involvement require chemotherapy as such patients may die before responding to hormone therapy. Conversely, hormone therapy will be appropriate treatment for oestrogen receptor positive patients with bone metastases, such patients benefiting from the longer responses and lower toxicity. Accurate staging should also allow identification of patients at risk of complications, such as pathological fracture, and facilitate appropriate intervention. Initial staging of ABC should include a chest radiograph, skeletal scintigraphy, with radiographs of all abnormal sites, and a liver US. Assessment of response to systemic therapy is based on symptoms, radiology and serum tumour markers. In patients with lytic bone metastases two or three marker sites should be radiographed at 3 months and all key metastases radiographed at 6 months. Lesions which have undergone radiotherapy cannot be used in the assessment of systemic therapy. Sclerotic metastases are radiologically unassessable, increased sclerosis may indicate progression or response. Skeletal scintigraphy has little role in assessment of response, as an osteoblastic response to therapy can cause a paradoxical increase in number and intensity of areas of abnormal uptake. MRI can be used to assess response, but no studies have prospectively correlated MRI response to International Union Against Cancer (UICC) criteria. Serum tumour markers (*e.g.* CA15-3, CEA and ESR) provide the only objective way to assess response of sclerotic bone metastases.

1135
Invited Review
Spinal metastases
V N Cassar-Pullicino
Department of Radiology, The Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry SY10 7AG, UK
Spinal imaging plays a pivotal role in the diagnosis and management of metastatic disease. The choice of imaging method will usually depend on the clinical setting. Used in isolation or combination, plain films, scintigraphy, CT and MRI confirm the presence of disease and detect the extent of involvement. Interventional techniques also play a role in selective clinical instances. The role of imaging constantly evolves as therapeutic advances in both the conservative and surgical management are realized.

1045–1130
Refresher Course
Lymphoma
Hall 10a

1045
Invited Review
Lymphoma: new concepts and imaging
B Morgan
Academic Department of Radiology, Leicester Royal Infirmary, Leicester LE1 5WW, UK
Since the introduction of the Rye/Lukes–Butler classification for staging of Hodgkin's disease (HD) in 1966, little else has remained constant in this field. Prognosis has been markedly improved, primarily due to the development of combination chemotherapy and advances in techniques, such as flow cytometry, immunophenotyping and molecular genetics, allowing a better understanding of the disease process. The use of combination chemotherapy has reduced the importance of accurate staging, which was vital when radiotherapy was the only available treatment. Treatment and prognosis of non-Hodgkin's lymphoma (NHL) is now more dependent on histopathological subtype (high or low grade) and disease bulk. Furthermore, in radiotherapy treatment of Stage I and II HD, second line chemotherapy retains the chance of cure in those understaged. Where does this leave the radiological investigation of the lymphomas? Staging is still required for the initial investigation and follow-up of treatment, although assessment may be more directed to measurable disease rather than the Anne Arbor system (especially high grade NHL). Staging laparotomy and lymphangiography have been largely abandoned in favour of cross-sectional imaging. The Anne Arbor system has been modified, accounting for cross-sectional imaging and disease bulk (Cotswold modification). Knowledge of disease-spread patterns for lymphoma subtypes allows the radiologist to aid and, occasionally, suggest review of pathological diagnosis. The radiologist may also suggest the possibility of previously unsuspected lymphoma, initiating repeat biopsy and immunophenotyping to reveal the diagnosis. In summary, the science of lymphoma has undergone radical change. This session will focus on the changing role of the radiologist, highlighting new concepts in the diagnosis, imaging and treatment of lymphoma.

1100–1150
Refresher Course
Interstitial Lung Disease
Hall 1

1100
Invited Review
Interstitial lung disease
S P G Padley and S Desai
Radiology Department, Royal Brompton Hospital, London SW3, UK
High resolution CT (HRCT) is now routinely requested by respiratory physicians. It is also increasingly requested by rheumatologists, intensivists and general physicians. As a result, HRCT is no longer confined to departments with a special interest in thoracic imaging. Accordingly, this update will be aimed at specialist registrars and consultants with an interest in CT, but without special expertize in thoracic imaging, who wish to stay abreast of the increasing demand for this investigation. Since the advent of HRCT in the mid 1980s this technique has been applied to almost every variety of parenchymal lung disease. The accompanying recognition of the diagnostic benefits has subsequently established HRCT as an essential investigation early in the diagnostic work-up of patients with suspected interstitial lung pathology. Such is the robustness of this technique that the need for more invasive tests of parenchymal lung disease and medium and small airway disease may be diminished or, in certain instances, removed altogether. This update will briefly review the anatomical basis of HRCT and the primary indications for the technique as they might be applied in any modern general imaging department. Some common diagnostic pitfalls will be reviewed. Recent refinements in HRCT technique will be discussed. The remainder of this update will then be devoted to recent developments in a number of areas. These will include the investigation of small airways disease in adults and children, recent insights into the correlation between HRCT findings and pulmonary function, both in chronic diffuse lung disease and acute lung injury, and a review of the significance of ground glass change.

1100–1130
Keynote Lecture
Continuing Professional Development
Hall 9

1100
Invited Review
Continuing professional development for radiographers
S Evans
The Society and College of Radiographers, 2 Carriage Row, 183 Eversholt Street, London NW1 1BU, UK
Radiographers have always maintained their competences to practice. It is indisputable that most radiographers working in the UK are fully capable of carrying out the roles and tasks presently

required of them. Thus, continuing professional development (CPD) is nothing new. However, few radiographers today could objectively identify and measure all the competences that enable them to practice safely and effectively. Nor would many radiographers be able to define the learning needs most appropriate to their immediate and future professional development needs. The Professions Supplementary to Medicine (PSM) Act 1960 is the Act of State Registration governing radiographers practising in the UK NHS. It has recently been reviewed and is in the latter stages of preparation for presentation to Parliament as a new bill. The revised Act will make explicit that all professionals registered under the Act are personally responsible for maintaining their competences to practice. In making such a requirement it becomes essential that every registered professional can *prove* continuing competence. The Society and The College of Radiographers (SCoR) have jointly developed an approach to measured professional development that meets the requirements of the revised Act and builds on the learning processes that already keep radiographers abreast of the developments in their fields of practice. The SCoR approach avoids the point-scoring cultures of some other CPD systems. Instead it encourages and facilitates reflection on learning and practice, to enable radiographers to plan their professional development in a way that gives confidence to their patients and the general public, and ensures every radiographer works most effectively within the clinical team.

1100–1245
State of the Art Symposium
Interaction of Imaging and Brachytherapy
Hall 10b

1100
Invited Review
Follow-up imaging—necrosis or recurrence
R P Beaney, K S Raju, D Hawkes and M Maisey
St Thomas' Hospital, Lambeth Palace Road, London SE1 7EH, UK
The persistence of a lesion after treatment, whether external beam radiotherapy, brachytherapy or chemotherapy is often a source of great anxiety for both the clinician and patient. A non-invasive method of assessing the nature of such a mass would allow the most appropriate treatment to be given. CT and MRI are the most commonly used imaging techniques. No consistent correlation has been identified between CT features, such as change in size or attenuation coefficients, and the presence or absence of viable tumour. Even CT guided biopsy is associated with about 80% accuracy due to sampling error. Positron emission tomography (PET) provides information on the metabolic behaviour of tissues. The glucose analogue 2-deoxyglucose labelled with the positron emmitter ^{18}F (^{18}F-FDG) is taken up more avidly in active tumour than in normal tissue. In areas of necrosis ^{18}F-FDG uptake is appreciably less than in normal tissue. This has led to its use in differentiation between treatment induced necrosis and tumour recurrence. In this presentation the role of PET scanning in the assessment of residual lesions will be demonstrated in: five patients with germ cell tumours post chemotherapy; five patients with gynaecological malignancy treated with radiotherapy, and five patients with brain tumours post radiotherapy. We have demonstrated that, in a non-invasive fashion PET, either alone or ideally in combination with CT or MRI, has a sensitivity and specificity in the region of 80% in differentiating between tumour recurrence and treatment-induced necrosis.

1130
Invited Review
Future developments in brachytherapy
P G M Scalliet
Department of Radiation Oncology, University Hospital St-Luc, Catholic University of Louvain, Brussels 1200, Belgium
Two (r)evolutions have conditioned the still active renewal of brachytherapy during the past 40 years. First, the replacement of radium by short-lived, artificial radioactive isotopes of a noticeably higher specific activity and/or lower energy has permitted the manufacturing of safer sources, from both the environmental and the radioprotection points of view. Second, the routine use of informatics in imaging and dose calculation allows better control of source position and dose delivery to the target and to the non-target surrounding structures. Conventional indications validated in large cohorts of patients include head and neck, breast and gynaecological tumours. Other indications, in rare tumours, include soft tissue sarcomas, paediatric malignancies, orbital tumours etc. Classical techniques make use of temporary implants delivering the radiation dose continuously over a few days. The requirement for hospitalization in shielded rooms, however, adds inconvenience for the patient to the high cost of shielding. New techniques have emerged (with the UK playing a pioneering role) where brachytherapy is given either as a permanent implant with ultra-low energy emitters (^{125}I) or as a series of short fractions (high dose rate) delivered with a very active source (10 Ci) connected to an automatic afterloading machine. New indications which have emerged over the past 10 years, namely prostate, lung and oesophageal cancer, all share the common advantage that the procedure can be carried out on an outpatient basis, *i.e.* more cost effective (and patient friendly) than conventional methods. The future includes the development of new sources (^{103}Pd for example), the generalization of 3D imaging of implants and the validation of the indications through clinical controlled trials. Radiobiological issues also need to be sorted out.

1215
Discussion

1115–1245
Controversy Corner
Medical Devices—the Case for Innovation
Olympian Suite

1115
Invited Review
Practical experience of the UK Regulations for Medical Devices
A Kent
Medical Devices Agency, Department of Health, Hannibal House, Elephant and Castle, London SE1 6TQ, UK
Shortly, only medical devices complying with the European Directive may be marketed in Europe. This will benefit industry by removing technical barriers to trade within the European Union; and the customer, by reducing the cost of regulatory compliance. Also, products should carry less risk for both the patient and user, since the regulatory threshold has been raised in most participating countries as different national controls have been replaced, and manufacturers have had to apply a new discipline to their design and manufacturing procedures. The new regulations group products by their perceived risk according to a set of rules and increase the degree of independent oversight as the risk escalates. Most radiological devices are judged to be of moderate risk and manufacturers have to contract with third party certification/auditing bodies, known as Notified Bodies, to confirm their products comply with the regulations. The Medical Devices Agency (MDA), as the Competent Authority, is responsible for enforcing the regulations throughout the UK. The MDA appointed all the UK Notified Bodies and regularly audits their work to ensure it remains of a high standard. Among its other responsibilities are the tasks of investigating post-market vigilance reports, and of reviewing applications from manufacturers intending to undertake a clinical investigation to demonstrate safety and/or side-effects of new equipment. Manufacturers must demonstrate and document that their products meet the relevant Essential Requirements for safety, listed in the European Directive. Often they will do so by meeting international technical standards. There is a need to support their claims through comprehensive records which are available for review by the Notified Body and/or the Competent Authority. The regulations apply to devices designed in a hospital or university as well as those designed and manufactured in the private sector.

1135
Invited Review
Medical device technology transfer and CE marking
J K Haywood
Regional Medical Physics Department, South Cleveland Hospital, Middlesbrough TS4 3BW, UK
A manufacturer who places a medical device on the market under his own name must meet the requirements of the Medical Devices Directive (93/42/EC). However, the directive recognizes and

exempts a device where the manufacturer is also the user, since such devices are not "placed on the market", for example, a hospital manufacturing for its own use. It should be noted that a concession is also extended to a hospital which commissions a third party to provide a product for a specified clinical or research commitment (but not for commercial exploitative purposes). Such commissions are already being executed by hospital departments of medical physics and bioengineering. The devices which result can have wide application because they respond to real healthcare needs. They have also been evaluated in the clinical environment and are near-market products suitable for transfer to small and medium scale enterprises. Transfer of this technology can be facilitated by a national forum where NHS and other innovators demonstrate their devices to potential manufacturers and where collaborative projects are conceived. One of the larger UK medical physics departments recognized this opportunity and secured support of the Regional Technology Centre (North), Institute of Physics and Engineering in Medicine (IPEM) and County Durham Development Company in order to mount a Medical Device Technology Transfer Fair. This was held successfully at Durham in May 1996. IPEM has followed this up by the formation of a Technology Transfer Panel. An NHS Network for Medical Equipment Development will shortly be launched.

1155
Invited Review
Are innovation and regulation compatible?
I R Young
Robert Steiner MRI Unit, Imperial College School of Medicine, Hammersmith Hospital, London, UK
When regulation of medical devices was introduced in the USA in 1976, the model used for the process was, by default, based on that developed for the licensing of drugs. The European Union, when it followed the American precedent, did so with additional rigidity and with extra motivation (to ensure the equality of access for products throughout the EU). The Medical Devices Agency in the country then interpreted the EU Directives with little understanding of the research and development process as it presently exists. If there were not significant hurdles in the path of innovation, the Department of Health's desire for full evaluation of new equipment presents additional problems for devices developed in this country, as do the cavalier view of IPR taken by most major corporations in most other countries. In order to justify his theories that innovation and regulation as at present formulated are ill-suited bedfellows, the author attempts to evaluate whether it would be possible to develop CT X-ray and MRI in the country today in the way in which they were. The approach involving a variety of university and industrial resources, with the support of major clinical institutions would have fallen foul of the prescriptions of the regulatory environment in a variety of ways. Indeed, in an atmosphere which was generally tolerant and supportive, it required FDA Review Committee to agree to treat three nominally competitive applications as one, to allow MRI, the first major modality to face the regulatory hurdle, to be approved by FDA. It is hard to see how a real innovation, such as MRI was, could succeed in reaching the market in the UK under present rules.

1215
Discussion

1130–1200
Keynote Lecture
Leonardo Goes LIVE
Hall 9

1130
Invited Review
Leonardo goes LIVE (the place of satellite broadcasting and continuing vocational education)
J E Henderson
Department of Radiography, University of Hertfordshire, Hatfield AL7 2PH, UK
Leonardo is a European funding mechanism designed to increase the collaboration between industry and the higher education sector. The project is based upon the GE customer support programme, offered via satellite throughout the majority of Europe. This paper will focus on the Leonardo project, jointly developed by the Department of Radiography at the University of Hertfordshire and its partners in Europe, including GE Medical Systems and departments of radiology in France and Italy, to look at the efficacy of satellite broadcasting of manufacturers' updates as a means of continuing vocational education (CVE). This is particularly important in the UK for radiographers, with the review of the PSM act making continuing professional development (CPD) compulsory. The paper will address the nature of CVE across Europe and will focus on the differences in radiography education in France, Italy and the UK, together with the differing roles of radiographers, as well as their specific CPD needs.

1145–1215
Keynote Lecture
Lithotripsy
Hall 10a

1145
Invited Review
The background and history of lithotripsy and its applications
D K Jones
United Medical Systems (UK) Ltd, Southport PR8 1SE, UK
This presentation firstly makes the audience aware of lithotripsy history and technological advance from the early days of development by German acrospace company "Dornier". The paper follows development through four generations of shock wave production, to present-day technology used by radiographers in the United Medical Systems team for treatment of urology patients with renal calculi. The second stage of the presentation gives a brief overview of the radiographer's role in a urology lithotripsy treatment session, from installation of the equipment in a day-case theatre to front-line maintenance. The final stage of the presentation explains the newest development in lithotripsy practice technology in the field of orthopaedics. It will include a brief case-study of a patient successfully treated for non-union of a long bone fracture using Medical Storz equipment in one of the hospitals currently visited by United Medical Systems.

1200–1245
British Institute of Radiology
Mackenzie Davidson Memorial Lecture
Hall 1

1200
Eponymous Lecture
Degenerative disc disease: natural history and imaging
M T Modic
Department of Radiology, Cleveland Clinic Foundation, Cleveland, OH 44195, USA
The sequelae of disk degeneration remain among the leading causes of functional incapacitation in both sexes and are an all too common source of chronic disability in the working years. By the age of 50 years, 85–95% of adults show evidence of degenerative disc disease at autopsy. The jump from the identification of an anatomic derangement to symptom complex must, therefore, be taken with caution, as to date there is only a moderate correlation between imaging evidence of disc degeneration and symptomatology. The natural history of lumbar disc herniations has engendered recent interest in MRI and has been an excellent tool for these investigations. Multiple studies have demonstrated that the prevalence of disc herniations in the asymptomatic population is in the range 20–30%. In the symptomatic population, studies have demonstrated that the size of disc herniation changes with time and patients treated conservatively demonstrate that the majority will show a reduction in size of 30–100%. The correlation between presenting symptoms and the type, size, location and behavior of disc herniations over time is complex and it has not been fully established that there are morphologic prognostic indicators relative to

outcome. In summary, degenerative changes appear to be a normal consequence of the aging process. MRI is an excellent modality for depicting them. The clinical relevance of these changes, however, remains to be established and the value of MRI as a prognostic indicator for patient outcomes needs to be more fully studied. At present, one can clearly recommend MRI as the single best presurgical decision-making tool, but its role in the evaluation of patients who are going to be treated in a conservative fashion appears to be much more limited.

1300–1345
British Institute of Radiology
Imation Mayneord Memorial Lecture
Hall 1

1300
Eponymous Lecture
High definition macroradiography
J C Buckland-Wright
Department of Radiological Anatomy, UMDS Guy's Hospital, London SE1 9RT, UK
INTRODUCTION: The successful design and development of microfocal X-ray units in the UK permit high definition macroradiography of patients. The shadow image of a region, placed close to the source (30 cm), is projected onto film 1–2 m distant. Within the image, characterized by high magnification (×4–×20) and spatial resolution (25–50 μm), changes in radiographic features are detected that approach that of histology. METHODS: Combination of an improved X-ray tube design with standardized radiographic and mensural procedures leads to enhanced image quality and hence improves the quality of data for analysis. Development of computerized methods permit quantitative assessment of the extent, progression and response to treatment of diseases affecting the human musculoskeletal system. APPLICATIONS: High definition macroradiography permits, for the first time, detection and measurement of: the repair of erosions in the hands of patients with rheumatoid arthritis following therapy; the effect of drug treatment in osteoarthritis of the knee, from a change in the pattern of joint space narrowing and the halt in osteophyte formation; the correlation between changes in subperiosteal resorption and the levels of parathyroid hormone in children with renal osteodystrophy; and, by employing newly developed techniques of fractal signature analysis, permit *in vivo* quantitation of cancellous bone of the spine in post-menopausal women and in the spine, hip and knee of patients with osteoarthritis. CONCLUSION: Quantitative macroradiography contributes significantly to both the basic and clinical radiographic science of diseases of the musculoskeletal system.

1300–1345
College of Radiographers
Welbeck Memorial Lecture
Hall 9

1300
Eponymous Lecture
Conflict or partnership?
A Yule
Council for the Professions Supplementary to Medicine, 143 Bryn Pinwydden, Cardiff CF2 7DG, UK
During the past four decades the Society/College of Radiographers, the Radiographers Board of the Council for the Professions Supplementary to Medicine and the International Society of Radiographers and Radiological Technologists have been striving for the advancement of the profession and for the well-being of patients. Although the three bodies had many common goals it appeared on many occasions that their interests and actions were opposed to one another. The review of the Professions Supplementary to Medicine Act (1960) will have consequences for all three organizations and, in addition, educational needs and technologies are changing on a worldwide basis. Fortunately, the last 10 years have seen excellent cooperation between these organizations that must be continually strengthened to maintain and improve healthcare in both the UK and the rest of the world. The Welbeck Memorial Lecture is dedicated to those people who have made a special contribution towards the advancement of radiography. Throughout the years many prominent members of the College of Radiographers have played important roles in the development of each of the above bodies. This lecture will therefore include a background/history of the three organizations, highlighting those involved and the parts they played in the development of our great profession. The present review of the PSM Act will have widespread implications in the future for all three organizations. History will be brought up to date by the presentation of the latest progress of the review and how future roles will be affected.

1400–1450
Scientific Session
Chest
Hall 1

1400
Bronchiolitis obliterans organizing pneumonia simulating bronchial carcinoma
[1]J M Murphy, [2]C Herold, [3]P Schnyder and [1]C D R Flower
[1]*Department of Radiology, Addenbrooke's Hospital, Cambridge, UK;* [2]*Department of Radiology, University Hospital of Vienna, Austria; and* [3]*Service de Radiodiagnostic, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland*
Bronchiolitis obliterans organizing pneumonia (BOOP) is a condition characterized pathologically by the presence of polypoid granulation tissue in the lumen of bronchioles and alveolar ducts, usually associated with interstitial and air space infiltration by mononuclear cells and foamy macrophages. This disease has a recognized association with rheumatoid arthritis, drugs such as amiodarone, sulphasalazine, penicillamine and acetbutalol, HIV infection, radiation injury and ulcerative colitis, but most cases are idiopathic. Idiopathic BOOP usually presents clinically with a persistent non-productive cough and one third complain of a flu-like illness with fever, sore throat and malaise. The appearances of BOOP on chest radiography (CXR) and CT most commonly is of patchy bilateral multifocal areas of consolidation, or ground glass infiltration, which are often subpleural or bronchocentric in distribution. A single area of consolidation and a diffuse reticular pattern are less common appearances. We report five cases in which BOOP presented as a solitary pulmonary nodule. Three patients had haemoptysis and in four cases the nodules showed evidence of cavitation on CT. The appearance in all cases was very suggestive of bronchial carcinoma, as a result of which the lesions were resected, the diagnosis of BOOP being made on histological examination of the resected specimens.

1410
Bronchopulmonary dysplasia in adult respiratory distress syndrome survivors: a consequence of mechanical ventilation
S R Desai, A U Wells, M B Rubens, T W Evans and D M Hansell
Department of Radiology, Royal Brompton Hospital, Sydney Street, London SW3 6NP, UK
PURPOSE: The pathophysiological consequences of adult respiratory distress syndrome (ARDS) and, specifically, the contribution of mechanical ventilation to residual lung damage are not known. The aim of the present study was: (i) to describe the spectrum of CT changes in previously ventilated survivors; and (ii) determine the relationship between follow-up appearances and changes during the acute phase and the duration of mechanical ventilation. MATERIALS AND METHODS: Thin-section CT obtained during the acute phase and at follow-up were analysed in 27 survivors of ARDS. The extent and distribution of pulmonary CT abnormalities were assessed. CT scores of acute and follow-up scans were compared and relationships between ventilation parameters and follow-up CT appearances were examined. RESULTS: At follow-up, a reticular pattern was the most prevalent [23/27 (85%) patients] and most extensive (median extent, 6.7%; range, 0–31.5%) CT abnormality. A striking anterior distribution of reticular change was observed (anterior quadrants > posterior quadrants; $p < 0.00001$). A reticular pattern on follow-up was negatively correlated with the extent of dense parenchymal opacification on acute scans ($r_s = -0.26$; $p < 0.00005$). The extent of a reticular pattern on follow-up scans was, however, independently related to the duration of

pressure-controlled inverse ratio ventilation ($p<0.0005$) and the total duration of mechanical ventilation ($p=0.02$) during the acute illness. CONCLUSION: A reticular pattern is a common finding on follow-up CT in ARDS survivors. It has a striking anterior distribution and is strongly related to the duration of mechanical ventilation. The appearances on follow-up CT are very similar to those described in infant bronchopulmonary dysplasia and may have a similar pathogenesis.

1420

Correlation of the reimplantation response on the post-transplantation chest radiograph with pulmonary oxygenation efficiency

A J Grainger, M J Ablett, L Mitchell and M J Keir
Departments of Radiology, Freeman Hospital, and Medical Physics, Royal Victoria Infirmary, Newcastle upon Tyne NE7 7DN, UK

PURPOSE: Following lung transplantation, the reimplantation response is almost invariably present on the post-operative chest radiograph. This study examines the relationship between the extent of the reimplantation response on the early post-operative chest radiograph following bilateral lung transplantation and the efficiency of pulmonary oxygenation, measured by the oxygenation index. METHODS: The early post-operative chest radiographs of 31 patients, who had undergone bilateral lung transplantation, were scored by two radiologists for the extent of the reimplantation response. The contemporaneous oxygenation indices (P_aO_2/FIO_2) were calculated and the data examined to assess the relationship between the chest radiograph scores and the oxygenation indices. RESULTS: The reproducibility of the chest radiograph scoring system was shown to be good with κ values >0.6 for scores from the two radiologists. However, there was little evidence of correlation between the chest radiograph scores and oxygenation indices. CONCLUSION: The extent of the reimplantation response on the early post-operative chest radiograph does not reflect the oxygenation efficiency of the lung transplant.

1430

CT appearances of the thymus and anterior mediastinum in active Cushing's syndrome

[1]J A Hanson, [1]S A Sohaib, [2]J D C Newell-Price, [2]N Islam, [2]P J Trainer, [2]J P Monson, [2]A B Grossman, [1]G M Besser and [1]R H Reznek
Departments of [1]Diagnostic Radiology and [2]Endocrinology, St Bartholomew's Hospital, London EC1A 7BE, UK

PURPOSE: ACTH-dependent Cushing's syndrome may be caused by a pituitary adenoma (85%) or an "ectopic" ACTH-secreting tumour (15%). Thymic carcinoids are one potential ACTH source. There is little data on the CT appearances of the thymus in hypercortisolaemic states, although involution might be expected. We describe CT appearances of the thymus and anterior mediastinum in a series of patients with active Cushing's syndrome. METHODS: CT scans of the anterior mediastinum in patients with active Cushing's syndrome, performed 1978–96 were reviewed. Subjects were classified into five groups. RESULTS: The CT appearances in 85 patients (55 female:30 male, median age 41, range 7–77 years) with active Cushing's syndrome were: (i) fat replacement with no soft tissue, $n=20$; (ii) linear strands of soft tissue, $n=24$; (iii) small nodule(s) <5 mm, $n=12$; (iv) larger nodule(s) ≥ 5 mm, $n=22$; (v) triangular bilobed thymus gland, $n=7$. The mean long and short axis diameters of the larger nodes were: $13\pm6\times10\pm5$ mm (including one patient with a 24×18 mm thymic carcinoid). The mean widths of the body, right and left limbs (group v) were 25 ± 7, 14 ± 3 mm and 12 ± 5 mm. Patients with thymic remnant tissue (groups iv and v) were younger than those with greater degrees of involution ($p<0.05$). CONCLUSION: 29/85 (34%) of patients with active Cushing's syndrome showed nodular or triangular soft tissue structures in the anterior mediastinum. Thus, such soft tissue structures do not necessarily imply a thymic carcinoid, although their presence in older patients should be viewed with suspicion.

1440

Tuberculosis in immigrants

G R Kaplan, R Mitchell, M I Shaikh, I Cropley, M Llewellyn, C Dore and R Davidson
Northwick Park and St Marks NHS Trust, Watford Road, Harrow HA1 3UJ, UK

Tuberculosis (TB) in immigrants remains a national health risk in the UK. 99 such immigrants with suspected active TB were referred to Northwick Park Hospital between 1993 and 1995 and screened for activity by chest radiograph (CXR) and bacteriology (sputum and/or culture positivity). Two radiologists separately assessed the CXR for extent of disease, cavitation and disease activity. The latter was the only variable which was significantly associated with the culture result ($p<0.001$) and there was no significant difference between the ratings of the two independent observers. Both radiologists subjectively assessed 43 CXR as having active disease. 28 out of the 99 patients were culture positive. 12 of these 28 were sputum positive. Correlation of the CXR with the sputum and culture results revealed four false negatives and 19 false positives. The positive predictive value for both radiologists in predicting the activity of TB from the initial CXR is 55% while the negative predictive value is 92%. Clinical follow-up of the false positive cases is incomplete, but so far four of the 19 patients were already having TB therapy, one had Group A *Streptococcus* and one had *Mycobacterium avium intracellulare*. A further two patients showed resolution of CXR changes after TB therapy and two patients showed clinical response to TB therapy. Radiological assessment of TB remains an important, independent, reliable and cost-effective screening tool.

1400–1445
College of Radiographers
Awards Ceremony
Hall 9

1400–1450
Scientific Session
MRI Physics
Hall 10a

1400

Multislice imaging techniques for multiplanar reformatting and image registration

J V Hajnal, A Oatridge and G M Bydder
Robert Steiner Magnetic Resonance Unit, Hammersmith Hospital, London W12 0HS, UK

PURPOSE: Reformatting of conventional multislice images into planes that are oblique to the original scan planes, frequently results in intensity errors and artefacts. In this study a technique for solving this problem has been investigated. BACKGROUND: Multislice acquisitions generally under-sample the object being scanned, even when contiguous slices are acquired. Artefacts result from the missing data, which can be filled-in by obtaining overlapping slices. To achieve this with a multislice acquisition, we double the repeat time (TR) and acquire two interleaved sets of contiguous slices that are offset by half a slice width. It is also necessary to control for slice-shape effects. METHOD: All studies were performed on a Picker 1.0 T HPQ system. Field echo and spin echo sequences were studied using phantoms and human volunteers who had given written informed consent. Comparisons were made between conventional contiguous slice sequences and the double TR-overlapped slice sequences, with various rf pulses. Images were reformatted using the slice centre separation distance to define the through slice length scale, rather than the conventional slice width. Images from repeat examinations were registered, reformatted and subtracted to look for intensity errors. RESULTS: Using the slice overlap method resulted in reformatted images without overt artefacts. The registered data showed virtually complete cancellation of brain structure on subtraction images when slice profile effects were kept under control. CONCLUSION: A multislice acquisition suitable for reformatting and registration has been demonstrated. This requires the acquisition of more densely spaced slices, which imposes a scan time penalty, but results in data that can provide information not normally available with multislice scans.

1410

Cerebellum segmentation from MRI scans using prior knowledge and texture analysis

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[1]Picker Research Group and [2]The Robert Steiner MRI Unit, MRI Unit, Hammersmith Hospital, DuCane Road, London W12 0HS, UK

INTRODUCTION: Manual methods of isolating the cerebellum structure from MRI scans are very laborious, monotonous, subjective and prone to operator errors. A semi-automated segmentation procedure has been developed to isolate the cerebellum.

MATERIALS: T_1 weighted, 3D RF spoiled volume scans were obtained on a Picker 1.0 T system (sagittal plane, TR = 21 ms, TE = 6 ms, flip angle 35°, FOV = 25 cm), 152 × 256 matrix, 114 slices of 1.6 mm thickness. The in-plane resolution was 0.97 × 0.97 mm. METHOD: A small seeding contour was installed by the operator within the cerebellum and replicated over several slices. The contour was produced to encompass both the grey and white matter and gave an approximate guide to the location of the cerebellum in relation to the whole head. The contour was dilated using a grey operation in conjunction with a 5 mm radius circular structuring element. This involved monitoring the intensity, texture and edge content properties within the structuring element in relation to the properties of the voxels enclosed within the previously dilated contour in a slice. If the range of these three variables in the structuring element agreed with those in the last dilated contour, then the central voxel in the structuring element was defined as belonging to the cerebellum; otherwise, the dilation ceased at the central voxel. RESULTS: The cerebellum was extracted from the scans of three normal adult subjects (32–39 years) and three schizophrenic patients (24–34 years) using the semi-automated segmentation procedure. The mean volume of the cerebellum differed by 1.86% of the mean volume obtained using manual delineation of the cerebellum boundary by an expert. CONCLUSION: An accurate, robust, fairly fast and objective method of segmenting the cerebellum has been developed that will aid in the monitoring of cerebellum volume changes in first episode schizophrenics and other groups of patients.

1420

The automatic detection and 3D visualization of the human ventricular system

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PURPOSE: Neurosurgery requires many years of training. It has been suggested that virtual reality models of the complex structures within the brain may aid in training and preparation for surgery. The Centre for Industrial and Medical Informatics (CIMI) is pioneering the development of a virtual reality model of the ventricular system of the brain. This model can be visualized and interacted in real-time using the facilities at the CIMI Reality Centre. This will lead the way forward in the development of a fully flexible training environment for neurosurgeons. METHOD: A T_2 weighted CISS scan was acquired from a healthy volunteer. This sequence consisted of 177 sagittal slices of array size 256 × 256 pixels, with a 1 mm pixel^{-1} resolution. A number of images from this data set were used to train a neural network, which was subsequently used to automatically segment the entire image volume. The ventricles were then extracted from the segmented images by the use of shape descriptors. A surface-rendered fly-through model of the ventricles was created. Neuroendoscopic images were texture-mapped onto the surface. Finally, the pulsing motion observed within the ventricles was simulated. CONCLUSION: We have developed an automatic method to extract the ventricles from MRI interacted within real-time. By using the MRI data directly, we have removed the need for costly animation that only approximates the shape of the ventricles.

1430

Initial benefits of an automated quality control system for functional MRI

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INTRODUCTION: BOLD contrast functional MRI (fMRI) studies may be badly affected if small signal changes due to neuroactivation are compromised by system drifts, changes in signal-to-noise ratio (SNR) and artefacts. These parameters have been monitored in two fMRI systems using an automated analysis program developed in-house. METHODS: Single shot T_2* weighted gradient echo echoplanar images are acquired daily in three orthogonal planes, using a standard fMRI protocol. Data is automatically analysed using custom-written software, producing measures of SNR, ghosting and maximum signal change within a temporal dataset. The data is automatically compared with previous results, using a method based on multirule Shewhart charting, alerting the operator to statistically significant changes. The program has been used to monitor scanner performance drifts and the effectiveness of subsequent interventions undertaken by the manufacturer.

RESULTS:

	SNR		Signal-to-ghost ratio (SGR)		Max. signal change
	Axial (R/L)	Axial (A/P)	Axial (R/L)	Axial (A/P)	
System 1	300	300	95	60	0.43%
System 2 (pre-interventions)	220	220	18	11	2.04%
System 2 (post-interventions)	280	271	35	27	0.9%

DISCUSSION: After significant equipment changes System 2's SGR has doubled, its maximum signal change halved and its SNR is now comparable with System 1. System 2's performance is approaching that of System 1 and may be considered for fMRI studies. Our quality control programme effectively monitors both a system's performance and its suitability to undertake an fMRI exam and has prompted a series of significant improvements in parameters directly affecting the quality of clinical fMRI results.

1440

Acoustic noise from fast imaging: safety evaluation of MR scanners

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INTRODUCTION: Acoustic noise generated by fast and ultra-fast pulse sequences is becoming an important safety issue in MRI. Many of the latest developments in the field have been underpinned by pulse sequences based on fast-switched gradients. These induce acoustic noise, through vibrations in the magnetic coils, which presents a safety hazard to the patient. In the case of interventional MRI acoustic noise could also present a hazard to operating staff. MagNET, the UK Magnetic Resonance Evaluation Team, is investigating the acoustic noise produced by a range of clinical MRI scanners. A review of previous work has been performed, where authors have reported acoustic noise levels up to 108 dBA. METHODS: Measurement methods were based on the NEMA standards publication no. MS 4, using integrating sound level meter, acoustic calibrator and omni-directional microphone insensitive to magnetic fields. Measurements were performed at the centre and entrance of the magnet bore of peak impulse sound pressure level and the time integral of the A-weighted sound pressure level. RESULTS: Acoustic noise levels are presented from three clinical MRI systems using "worst case" pulse sequences. These consist of high gradient duty cycle and gradient current amplitudes. CONCLUSION: The results of this work have lead to a protocol for acoustic noise measurement which is to be included in MagNET Technical Assessments.

1400–1530
State of the Art Symposium
Image Guided and Intraoperative Brachytherapy
Hall 10b

1400

Invited Review

Prostate implantation

A Flynn
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^{125}I seed implantation has been used for several years for treatment of prostate carcinoma. In early cases the seeds were implanted intraoperatively, but these treatments were generally regarded as unsatisfactory, mainly because of the difficulty of placing seeds in the required positions within the prostate. More recently, Blasko and his co-workers in Seattle have developed a technique which uses trans-rectal US to pre-plan the treatment and guide the positioning of the seeds at the time of their implantation. Adaptations of this technique are now in common use in the USA. The method has been adopted by Cookridge Hospital, Leeds for the treatment of early stage prostate carcinoma. Once the patient, having satisfied

the entry criteria, is accepted for treatment, a transrectal US "volume study" is performed, which provides cross-sectional images through the prostate at 5 mm intervals. A treatment plan is produced from this which identifies the precise position of each of the seeds required for the treatment. Typically, a treatment plan will require 80–120 seeds. At implantation, the patient is positioned so that the US images of the volume study are reproduced and a template is used to position the needles containing the seeds, so that they may be deposited at their pre-determined positions within the prostate. The position of the seeds and needles are visualized by US and fluoroscopy during implantation. Seed placings are checked by simulator radiography and, in some cases, by CT. Patients usually return home the same day.

1415
Invited Review
Image guided placement of brachytherapy catheters for gliomas
[1]P R Eldridge, [1]J Bosma, [2]C Lee, [2]R Clements, [1]P Byrne and [2]B Jones
[1]*The Walton Centre for Neurology and Neurosurgery and* [2]*Clatterbridge Centre for Oncology, UK*
Treatment failure in malignant gliomas is most frequently due to local recurrence. There is some evidence that local control is improved if a high local dose of radiation can be given. Delays between cytoreductive surgery and radiotherapy, as well as during radiotherapy, may predjudice effective therapy owing to the problem of cellular repopulation. It is logical, therefore, to combine all treatment modalities within a reasonable period of time. Interstitial radiotherapy can achieve the objective of providing a high local dose to the tumour and, in our practice, is given either before or after external beam radiotherapy. The method uses high activity ^{192}Ir delivered through an afterloading catheter, using multiple dwell positions and times. Using the Micro-Selectron after-loading system no particular radiation protection measures are necessary for the patient or family and the system provides a good conformal dose distribution, using relatively few catheters. A frameless, image-directed, surgical system (ISG-Elekta) is employed to place the catheters. The frameless system allows planning to be performed at leisure, using an image data set obtained the week prior to surgery. This data set is edited on a voxel-by-voxel basis to "mark" the intended track of the catheter or catheters; once in theatre the patient is matched to the image using a surface-fitting registration technique, which obviates the need for fiducial markers enabling the "planning" data set to be acquired well in advance of surgery. Advantage can also be taken of multiple MRI sequences to provide extra information to determine the target area. The system is then used to guide the alignment of a drill hole in the skull, through which a catheter is placed and held securely in position by its snug fit in the bone of the skull. Post-operative imaging confirms the exact positioning of the catheter and final adjustments in dose can be made a further advantage of the multiple dwell positions and times. In practice the error between the intended position and actual position is <2 mm. Eight patients have been implanted, all with Grade IV glioma. Two cases were for recurrence and six performed as part of the primary treatment. In several cases radionecrosis occurred and was symptomatic, the image-directed system was used to resect such necrotic tissues and allow targeted biopsies. The patients with recurrence survived 12 and 8 months from the date of brachytherapy and 26 and 35 months from the date of presentation. One of the cases treated primarily survived 18 months, dying from distant recurrence. The remaining five cases continue to survive (range 1–14 months), though one has recurred locally.

1430
Invited Review
Ear, nose and throat techniques
P Scalliet
UCL Clinique University, St Luc, 1200 Brussels, Belgium
Abstract not available.

1445
Invited Review
Conformal brachytherapy for the treatment of the parametria in gynaecological malignancies
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PURPOSE: Approximately half of the patients who have relapsed carcinoma of the cervix after primary surgery or radiotherapy have disease on the pelvic side wall. Whilst radical external beam therapy may be possible in unirradiated patients, this is associated with high morbidity and is impossible in those whose primary treatment was radiotherapy. Surgery may be used to debulk pelvic side wall disease, but complete eradication is not usually possible because of intimate involvement of the large vessels in a tumour. A system of localized intraoperative brachytherapy to the tumour bed is therefore attractive, as a high local dose can be achieved whilst packing sensitive normal tissues away from the irradiated area. METHOD: After tumour resection, narrow catheters, which will guide the HDR iridium brachytherapy source, are carefully stitched onto the pelvic side-wall. These catheters are positioned to give a specified dose at a distance from the source. Spacers can be used to distance the source from the tumour bed to conform the volume irradiated to the required shape and treatment depth. Orthogonal X-rays of the catheters containing dummy marker wires, are taken in the operating theatre to enable accurate dosimetry to be performed before the treatment is delivered. RESULTS: Dosimetry is calculated to give a reasonably uniform dose to the specified area. This may require some optimization of source position and dwell times. However, the dosimetry is "real time" and optimization takes time, which needs to be minimized whilst the patient is under anaesthetic. The radiation dose is prescribed at a distance from the source and delivered in a single fraction over a few minutes. The catheters are then removed and the surgical procedure is completed. CONCLUSIONS: This conformal brachytherapy technique, although labour intensive for staff (as is all high dose rate brachytherapy), spares patient and external beam treatment time. The radiation dose is delivered to a well defined volume, minimizing dose to critical organs and allowing boost doses to be delivered to previously irradiated areas.

1500
Invited Review
Parametrial implants
A E Howes
Joint Center for Radiation Therapy, Boston, MA 02115, USA
Radiation therapy of locally advanced cancer of the cervix and vagina may not be amenable to standard combinations of external beam and intracavitary techniques. For some patients, optimal delivery of radiation dose may be feasible by the use of template guided, interstitial, afterloading methods. Initially, these techniques were developed using intra-operative placement of catheters inserted via the perineum. Currently, with the use of ultrasonic, CT or MRI-guided imaging, catheters can be optimally placed by blind-ended insertion of sharp-pointed, hollow plastic catheters through the perineum into the parametrial tissues. Although developed for continuous, low dose rate radiation delivery, the techniques have now been adapted for high dose rate treatment using remote afterloaders. Higher total minimum tumour doses can be delivered with parametrial implants compared with conventional techniques, resulting in a higher probability of local tumour control. Risk of complications, such as fistula formation, exist but can be minimized by avoiding placement of catheters into rectal or bladder mucosa. Current practice of interstitial parametrial implantation in the USA will be reviewed, and results of experience at the Joint Center for Radiation Therapy will be presented.

1515
Invited Review
The interaction of imaging and brachytherapy in colorectal cancers
S Myint
Clatterbridge Centre of Oncology, Wirral, Merseyside L63 4JY, UK
Pre-operative evaluation of colorectal tumour is important for staging and information thus obtained could be used to plan the treatment strategy which is suitable for the individual patient. In the conservative treatment of rectal carcinomas it is important to determine the local extent of tumour. Both intraanal ultrasound and intraanal MRI can be used to determine the local depth of infiltration of the tumour and to assess the perirectal lymph node enlargement. If there is infiltration into the muscularis propria, or if there is evidence of perirectal lymph node enlargement, then the patient is not suitable for local contact radiotherapy (brachytherapy) alone and those patients are offered external beam radiotherapy initially, followed by contact radiotherapy boost. For anal carcinomas, chemoradiotherapy is now the standard treatment in the UK and external beam radiotherapy, together with chemotherapy, is offered initially, followed by interstitial brachytherapy. Evaluation of the tumour prior to brachytherapy could help to determine the local extent of the tumour and could be used as a guide to placement of needles for afterloading the iridium wires, thus ensuring adequate coverage of the tumour volume and allowing pre-treatment planning to determine the length and the number of the needles required. Bulky recurrent tumours are treated initially with pre-operative chemoradiotherapy followed by attempted

resection in selected patients who are fit with no evidence of metastatic disease. Imaging prior to surgery could help to determine the extent of residual disease and may be useful as a guide for placement of catheters at the time of operation to allow adequate coverage of the tumour volume. The interaction of imaging and brachytherapy in the above circumstances are evaluated with cases treated at Clatterbridge Centre for Oncology.

1400–1545
Workshop
How to Survive an Inspection by the Regulators
Hall 11a

1400
Introduction

1410
Invited Review
An inspector calls ... the HSE
J R Taylor
HSE, 14 Cardiff Road, Luton LU1 1PP, UK
Many radiology and nuclear medicine departments in hospitals will be subject to an inspection by the Health and Safety Executive from time to time. One of the purposes of this inspection will be to assess compliance with the Ionising Radiations Regulations 1985 [IRR(85)] and much of the Ionising Radiations (Protection of Persons Undergoing Medical Examination and Treatment) Regulations 1988 (POPUMET). This paper, by a serving Principal Specialist (Radiation) HSE inspector, will outline the format of a typical inspection under these regulations and detail some of the main areas where experience has taught that many hospitals fail to achieve full compliance. Good radiological protection practices will also be discussed.

1430
Invited Review
An (HSE) Inspector calls ... the RPA
K E Goldstone
East Anglian Regional Radiation Protection Service, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK
To survive a visit from a Health and Safety Executive (HSE) Inspector, the Radiation Protection Adviser (RPA) must be well prepared and, in so far as he/she is able, ensure the Employer he advises is also well prepared. It is essential that the RPA remains keenly aware of their advisory role and firmly distinguishes it from any executive powers they may have. An HSE visit to a hospital may be as part of an HSE swoop—in which case radiation protection may form only a small component of the whole inspection—or it may be in response to a reported incident. This presentation will consider both types of visit and how the RPA can prepare for them in order to make them an enjoyable and worthwhile experience.

1445
Invited Review
How to survive an inspection by the Environment Agency
I D Jackson
Environment Agency, Radioactive Substances Regulation Team, Millenium House, Fleetwood Park, Fleet GU13 8UT, UK
The Environment Agency regulates the keeping and use of radioactive material and the accumulation and disposal of radioactive wastes under the Provisions of the Radioactive Substances Act 1993. In this paper, an Agency Inspector explores what the regulator wants and the common difficulties faced by hospital staff in complying with authorization conditions. This Symposium will take the form of an interactive debate between the Environment Agency, the Health and Safety Executive, healthcare professionals and Hospital Radiation Protection Advisers.

1505
Invited Review
An Inspector calls ... the Radiation Protection Adviser
S Batchelor
Medical Physics Directorate, Guy's and St Thomas' Hospital Trust, London SE1 9RT, UK
The Radiation Protection Adviser (RPA) is generally the key interface between the regulator and the employer. Not surprisingly, the RPA is often in an uncomfortable position being very much at the sharp end during an environment agency inspection. Factors such as: lack of resources within their own services, as well as within departments undergoing inspection; lack of motivation of individuals within inspecting departments; and perhaps a misplaced priority within higher management on radiation protection issues by employers, can make the RPA feel very vulnerable which, in turn, can affect relationships with the visiting inspector. What steps can the RPA take to ensure that the inspection is of value and that sanity is retained? Some suggestions include: (i) long before the inspection, ensure that the relevant staff have received appropriate training. If not, one cannot be surprised if sources are incorrectly kept, disposed of etc. General laboratory workers need at least a day course and Radiation Protection Supervisors (RPSs) need a 3–5 day course (obvious exceptions being an RPS/ward sister involved with brachytherapy treatments). Involve one of your team in the inspection for their own benefit (continuing professional development!). (ii) Plan the day as much as you can. Let the RPSs know what is expected of them, so that they have all the right records and documents available. (iii) Think about the most pressing problems that you, as the RPA, experience at this centre—inspectors generally ask what problems you have. They can be supportive over many issues. Select the most appropriate one(s) so that you may have the opportunity of raising it (them), if appropriate. (iv) Inform management that the inspection is occurring and be open about the potential consequences. People are happier if they hear good news after being warned of potential bad news, than if they were not aware at all and then told they are pending legal action! (v) Be prepare to live and learn, do not take criticism personally, ask to discuss further giving your interpretation of the issue and show that previous problems have progressed or been resolved. Examples of real and potential difficulties encountered during inspections will be given.

1520
Discussion

1400–1540
Scientific Session
Ear, Nose & Throat
Hall 11b

1400
Invited Review
PET FDG—expensive imaging gimmick for head and neck cancer?
W L Wong
Paul Strickland Scanner Centre, Mount Vernon Hospital, Northwood HA6 2RN, UK
Clinical examination is capable of identifying most symptomatic cancers of the head and neck, but submucosal spread and extension of tumour into deep structures is often difficult to assess. The determination of nodal status by palpation is inaccurate (false negative results, $\leqslant$39.9%; false positive rates, $\leqslant$35%). Conventional anatomical imaging cannot reliably and consistently delineate the lesion at the primary site, or identify nodal metastases. A second problem is the diagnosis of persistent/recurrent disease following treatment, which is often delayed because fibrosis obscures early signs of recurrence. These limitations in diagnosis result in patients being over- and under-treated, with consequent effect on survival and morbidity. There is an urgent need for imaging techniques that are able to accurately delineate disease at the primary site, identify early nodal metastasis and document persistent and recurrent disease. This will permit the tailoring of treatment to individual patient needs. Positron emission tomography (PET) imaging makes use of radio nuclides which decay with emission of positively charged particles (positrons). The radionuclide-labelled tracer can be used to measure different aspects of tissue function. Cancer cells have increased glucose metabolism and 2-[^{18}F]fluoro-2-deoxy-D-glucose (FDG), a radionuclide-labelled analogue of glucose, can be used to study tumours *in vivo* by exploiting the difference in glucose metabolism between malignant and normal tissue. PET FDG has been shown to be more sensitive than conventional imaging at detecting malignancy at a variety of sites. The value of PET FDG for detecting occult primary lesions, staging the neck before and after treatment, detecting recurrent/residual disease, and for monitoring early response to treatment in patients with head and neck squamous cell carcinoma will be considered. The added-value of computer combined CT/MRI and PET FDG imaging for planning treatment will be demonstrated.

1430

Comparison of Hertel ophthalmometry with MRI measurements of proptosis

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PURPOSE: To establish normative values for degree of proptosis from MRI images and compare with Hertel ophthalmometry. To compare normative data with MRI measurements in clinically proptosed patients. METHODS: 50 patients without thyroid or orbital pathology and with no clinical or ophthalmometric evidence of proptosis were examined by Hertel ophthalmometry followed by MRI (5 mm axial proton density sequences at 1.0 T). Distance to anterior and posterior surface of globe and to anterior surface of lens was measured from either (i) ipsilateral frontozygometric process (FZP) or (ii) a line joining right and left FZP. Distance to anterior and posterior surface of globe from (iii) a line joining FZP to anterior lacrimal crest medially was also calculated. Measurements were compared with contralateral side and with ophthalmometry. Measurements were also performed on 12 patients with clinical proptosis. Interobserver and intraobserver variability was calculated for both MRI and ophthalmometric measurements. RESULTS: Distance to anterior globe from baseline (ii) (MRI analogue of Hertel measurement) was simple to obtain and reproducible (intraobserver variability 0.45 ± 0.59 mm compared with 1.00 ± 1.15 mm for ophthalmometry). This measurement gave the most significant difference between the non-proptosed and proptosed group. MRI measurements were typically smaller than Hertel equivalent (mean 3.48 mm). All baseline to anterior globe or lens measurements were significantly different between proptosed and non-proptosed groups. Baseline to posterior globe measurements was not statistically significant between groups. CONCLUSION: MRI can provide reliable and reproducible indicators of proptosis.

1440

Nasolacrimal stenting and dacrocystoplasty for epiphora

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PURPOSE: Epiphora is a common problem, previously treated surgically. Newer techniques have involved the fluoroscopic balloon dilatation (DCP) and placement of nasolacrimal stents (NLS). We studied NLS and DCP prospectively in patients with epiphora. METHOD: All patients had an initial dacrocystogram to classify the cause of epiphora and level of obstruction or stenosis. Under regional anaesthesia we inserted NLS or performed DCP. Radiation doses during insertion were recorded. All patients were followed-up at regular intervals after the procedure by telephone and further radiological investigation. RESULTS: 31 nasolacrimal systems were stented, 67% for obstruction. Technical success (immediate patency) was achieved in 27 (87%). At 14 days, the primary assisted patency rate was 63% (17/27) and a further seven patients (26%) had symptomatic relief. 10 (37%) stents were removed following stent failure. 23 patients had DCP, technically successful in 17 (74%). 10 (59%) of 17 patients restudied achieved radiological patency. The mean radiation dose was 198.7 cGy cm^{-2} in the stented group. The long-term results will be presented. CONCLUSION: Nasolacrimal stenting and DCP are simple and effective ways of treating epiphora non-surgically, with a low technical failure rate and few complications. In addition, the radiation dose for the procedure is low and stents are easily removed and replaced if necessary.

1450

Quantification of the effects of the topical decongestant oxymetazoline by MRI and posterior rhinomanometry

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PURPOSE: The most commonly used method of assessing medical treatment of the nose is posterior rhinomanometry, in which airflow through the nose during quiet respiration is used to calculate the nasal airway resistance (NAR) to this flow. However, rhinomanometry has a significant patient-learning curve and, more importantly, it can not accurately assess specific areas of the nasal cavity. This study was designed to test the efficacy of MRI as a method of quantifying regional changes in mucosal volume following the application of a topical decongestant. METHODS: 12 normally healthy volunteers suffering from a common cold underwent posterior rhinomanometry and MRI both prior and 40 min after administration of either the topical decongestant oxymetazoline hydrochloride (100 μg) or a placebo. Inspiration NAR was measured at a reference pressure of 75 Pa using an NR6-2 rhinomanometer. All MRI was performed using a 1.5 T GE Signa scanner. Images of the paranasal sinuses, encompassing the tip of the nose to the posterior wall of the sphenoid sinus, were obtained in the coronal plane using a T_2 weighted FSE sequence incorporating fat saturation. Total mucosal volumes were subsequently determined for the antral maxillary sinuses, inferior turbinates, middle turbinates, superior turbinates plus ethmoid sinuses and nasal septum, using a seeded thresholding method. RESULTS: Seven patients were randomized to receive the decongestant and the remaining five received the placebo. Comparison of the post-treatment NAR measurements for the two groups revealed a significant difference ($p = 0.0042$). Comparison of mucosal volume for the two groups revealed significant differences for the inferior turbinates ($p = 0.0024$) and nasal septum ($p = 0.0234$) only. There was no significant difference for the antral maxillary sinuses ($p = 0.1371$). CONCLUSIONS: On administration of a topical decongestant MRI can be used to assess regional changes in mucosal volume and, therefore, may have a role in assessment of the efficacy of common cold treatments.

1500

Facial swelling due to salivary gland disease: MRI as a single investigation

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PURPOSE: To establish whether MRI could serve as a radiation-free initial investigation in patients presenting with facial swelling, presumed to be due to salivary gland disease. METHODS: 20 patients presenting with facial masses in the region of the major salivary glands were submitted consecutively to MRI. The examinations were done without reference to prior investigations. The findings were correlated with those of surgical exploration and clinical follow-up, where relevant, and with results of other investigations made prior or subsequent to MRI. RESULTS: Masses were found in 11 patients whose subsequent course confirmed the MRI findings in all cases. Tumours were correctly excluded in nine patients, some of whom showed characteristic findings of inflammatory disease, including duct dilatation and fatty infiltration. Neither prior nor subsequent investigations added further information. CONCLUSION: This pilot study indicates that MRI may be an effective single investigation in this clinical setting, although initial OPG may be desirable to exclude the common possibility of dental infection. The study is on-going and up-dated results are presented.

1510

Video fluoroscopic assessment of swallowing in stroke patients, is there a reliable alternative?

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PURPOSE: To determine whether there is a reliable, less invasive method than video fluoroscopy (VF) in the assessment of swallowing and aspiration in stroke patients. MATERIALS AND METHODS: A randomized prospective study compared VF with speech therapy assessment (STA) of swallowing in 55 confirmed stroke patients, age range 51–90 (mean 69 years). Examinations were performed in the fluoroscopy suite with the examiners blinded to each other's findings. Each patient undertook 10–15 swallows per examination. RESULTS: There were 669 separate swallowing episodes, of which 132 were excluded due to missed observation by one or other of the examiners. Of the 537 swallowing episodes jointly assessed, 43 (8%) were seen to aspirate on VF, 31 of which (72%) were identified by STA with 42 (8%) false positive assessments. Overall, 14/55 patients aspirated on VF of whom 13/14 (93%) were positively identified by STA. CONCLUSION: VF will remain the "gold standard" in the overall assessment of swallowing disorders in stroke patients. However, our results suggest that, in co-operative patients, speech therapy assessment of aspiration can be a reliable alternative to VF which may be performed at the bedside.

1520

Madelung's disease: US, CT and MRI appearances

A T Ahuja, A D King, E S Y Chan, J Kew and W W M Lam
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PURPOSE: Madelung's disease is a condition in which there is excess fat in the neck. We describe the distribution of fat on US, CT and MRI and evaluate the pre-operative role of each modality. MATERIALS AND METHODS: Eight patients with Madelung's

disease underwent US, CT and MRI of the neck. The detailed distribution of fat within the neck was studied. The ability of each modality to demonstrate the course of the major vessels within the fat, detect tracheal compression and incidental. In patients with Madelung's disease excess fat is predominantly present in the subcutaneous tissues of the neck posteriorly (eight), under the trapezius (eight) and sternomastoid (six), in the supraclavicular fossa (five), between the paraspinal muscles (five), in the suprahyoid anterior neck (seven), infrahyoid anterior neck (three), superior mediastinum (three) and prevertebral space (two). Excess fat deposition was also seen in the pretracheal space (one), extrapleural space (two), and over the cheeks (one), sites previously not described. Overall, MRI provides better pre-operative information to the surgeon. CONCLUSION: MRI is the pre-operative investigation of choice for Madelung's disease. If MRI is unavailable, non-contrast CT also provides the surgeon with adequate information.

1530

Ultrasound features of lipomas of the neck

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PURPOSE: The diagnosis of a cervical lipoma may not always be evident on clinical grounds and may present to the ultrasonographer as a soft lump of unknown aetiology. This study describes the sonographic features of head and neck lipomas. MATERIALS AND METHODS: US of the neck was performed using a 7 and 10 MHz transducer in 25 patients with lipomas who presented with a soft tissue mass in the neck. The diagnosis of a lipoma was suspected on clinical examination in only eight patients. RESULTS: Lipomas were well-defined (88%), compressible (100%), elliptical masses with the longest diameter parallel to the skin surface. Compared with the adjacent muscle, 76% of all lipomas were hyperechoic, 8% isoechoic and 16% hypoechoic. All contained multiple echogenic lines parallel to the skin surface, with no evidence of posterior enhancement or attenuation and no flow on colour Doppler. CONCLUSION: The characteristic US appearance of a cervical lipoma is an elliptical mass parallel to the skin surface which is hyperechoic compared with adjacent muscle and contains linear echogenic lines at right angles to the US beam. The differential diagnosis is discussed.

1400–1430
Scientific Session
Image Processing
Olympian Suite

1400

Analysis of dynamic Gd-DTPA enhanced MRI of the breast using neural networks

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INTRODUCTION: Due to the overlap in the morphological appearance of benign and malignant lesions on post-contrast images, dynamic contrast enhanced (DCE-MRI) scanning has been used to aid differentiation. This results in variable specificity (37 95%), with most authors quoting values around 80%. This study investigates the use of neural networks to analyse DCE-MRI data in an attempt to more consistently differentiate between pathologies. METHODOLOGY: Images were acquired on a 1.5 T GE Signa system using a dedicated breast coil. DCE-MRI was performed on 103 patients (69 malignant 34 benign) on whom histological confirmation was available. An FSPGR sequence was employed (TR/TE/α = 11.1/4.2 ms and 30°) with 25 images acquired at four slice locations at a temporal resolution of 11.6 s. Regions of interest (ROI) were drawn manually around areas of abnormality from the FSPGR images. Pre-contrast images were used to determine a base-line from which the percentage change in enhancement was calculated for each time-point. These time courses were then assessed independently by two observers blinded to the histopathology. These data were also presented to various neural networks as 25 separate inputs. These were then evaluated using 81 patient data sets for training. 15 for testing and 10 reserved for prediction of accuracy of the trained network. RESULTS: The probabilistic neural network achieved a classification accuracy of 90%, compared with 85% for a back-propagation network. This compared with only 76% and 72%, respectively, for experienced observers. CONCLUSION: Neural networks offer a reliable, fast and operator-independent method for analysing DCE-MRI data, it is anticipated that inclusion of morphological information may improve results further.

1410

Optimal wavelet transform enhancement and classification in digital mammography

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This study investigated the performance of all the real wavelet functions when used for mammographic image enhancement and classification. The images were analysed by using the following wavelet architectures: logarithmic splitting, uniform splitting (or wavelet packet) and adaptive splitting. The enhancement procedure is based on the alteration of the multiscale wavelet transform coefficients. The pattern-recognition approach incorporates 20 statistical measurements and five different classifiers. A large set of digitized normal and abnormal mammographic images (obtained from the MIAS database) was used in order to evaluate the performance of the wavelet transform analysis and classification. Our results suggest that (i) the wavelet enhancement technique analysis can be used as a potential discriminator for mass abnormalities, and (ii) the adaptive wavelet transform method for mammographic classification provides higher classification accuracy than other wavelet-based techniques.

1420

Non-negative steepest descent method for image reconstruction: application in single photon emission CT

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PURPOSE: In this study, a new image reconstruction technique, called non-negative steepest descent method (NNSDM), was developed for single photon emission CT (SPECT). This method involves using the non-negative constraints as a regularization technique, giving images with high spatial resolution and a low level of noise. METHOD: This technique formulates the reconstruction problem into a set of linear algebraic equations. The tomographic image can be reconstructed by minimizing the error function of the linear algebraic equations using NNSDM. The NNSDM starts with conventional steepest descent search for the least squares solution. Once the search reaches the boundary, it will change direction along the boundary. This second search has been accelerated using a line minimization method. After a certain number of iterations, an image will be reconstructed. A computer simulation was done which involved the reconstruction of a multiple squares phantom image from its sinogram, with and without gaussian noise. After the computer simulation, a multiple cylinders and Hoffman's brain phantom with radioactivity inside were scanned. Images were reconstructed from the sinograms using filtered back-projection (FB) and NNSDM. The full width half maximum (FWHM) values of the multiple cylinders images were measured. RESULT: 100% recovery can be shown in the computer simulation from the noise-free sinogram of the multiple squares phantom. In comparison with the images reconstructed by FB, higher resolution and more accurate details can be obtained by NNSDM. CONCLUSION: In conclusion, NNSDM can provide higher quality, more accurate images for quantitative functional imaging.

1500–1640
Scientific Session
CT Chest
Hall 1

1500

Percutaneous transthoracic needle biopsy: a survey of thoracic radiologists in the UK

S Phillips, G Brown and H Adams
Department of Diagnostic Radiology, Llandough Hospital, Penarth CF64 2XX, UK

AIMS: To determine national practices in percutaneous transthoracic needle biopsy (PTB) techniques. BACKGROUND: There are no recently published guidelines on PTB, however, the American

Thoracic Society guidelines of 1989 advocated the presence of a cytopathologist at the procedure. Furthermore, these guidelines stated that cutting needles should not be used in lesions in or adjacent to the mediastinum or hilar areas. METHOD: A postal questionnaire was sent to 78 members of the UK Association of Chest Radiologists. RESULTS: 51/78 (65%) replied. Of these 50/51 (98%) performed biopsies. The number of biopsies performed per annum by each radiologist ranged from 5 to 250. Fine needles aspiration (FNA) was the preferred technique in the biopsy of pulmonary lesions for 14/50 (28%), cutting needle for 16/50 (32%) and 20/50 (40%) radiologists used both needles. 35/39 (90%) of radiologists performing mediastinal biopsies used cutting needles. Immediate cytological analysis was available to 17/50 (34%) of radiologists. The only radiologists utilizing FNA as their preferred technique for mediastinal biopsy were those who had access to immediate cytological analysis (4/39). The average number of aspirations each radiologist was prepared to attempt in centres with immediate cytological analysis was 3.9, compared with 1.9 in those centres without. CONCLUSION: This survey demonstrates that access to immediate cytopathological analysis may influence both needle selection and the maximum number of biopsy attempts performed to achieve a diagnosis. The widespread selection of cutting needles for mediastinal biopsy is contrary to previously published guidelines and suggests that a revision of guidelines for PTB may be necessary.

1510
CT-guided percutaneous needle biopsy of lung and chest lesions: our experience with 66 patients

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Department of Radiology, Royal Free Hampstead NHS Trust, London NW3, UK

PURPOSE: To evaluate retrospectively our success in obtaining diagnostic tissue samples, along with reviewing the incidence of complications in patients undergoing CT-guided biopsy of the lungs and chest. We also reviewed whether the site of lesion or the method of biopsy influenced the above. METHODS: 66 consecutive patients who had undergone CT-guided biopsy of thoracic lesions were identified; 58 patients had peripheral lesions biopsied, while eight had central lesions sampled. 37 of the interventions were by a core biopsy method, using an 18–20 gauge cutting needle, while in 29 cases fine needle aspiration (FNA) was used to obtain the tissue. RESULTS: Of eight central biopsies, six (75%) yielded diagnostic tissue with no recorded complications. This compared with 58 peripheral biopsies, of which 33 (57%) were diagnostic, with nine (16%) recorded complications. The method of biopsy was divided between 37 patients having a core biopsy and 29 patients having FNA. The diagnostic yield of the core biopsy group was 30 (81%) *vs* 20 (69%) in the FNA group, while the complication rate was seven (19%) *vs* two (7%) respectively. CONCLUSION: There is a greater incidence of complications in patients undergoing CT-guided biopsies of peripheral lung/chest lesions. Core biopsy techniques increased the yield of diagnostic tissue, but with a higher complication rate.

1520
Incidence of pneumothorax on chest radiographs after CT-guided lung biopsy

J Berger, Z Traill and F V Gleeson
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PURPOSE: Reports in the literature suggest that patients are more likely to develop a pneumothorax during a CT-guided than fluoroscopy biopsy. The purpose of this study was to determine the incidence of pneumothorax detected by chest X-ray after CT-guided percutaneous fine-needle aspiration biopsy. METHOD: A retrospective review was performed of the post-biopsy chest radiographs and CT sections of 88 patients who underwent CT-guided fine-needle (22 G) aspiration lung biopsies of pulmonary nodules not abutting the pleura. Post-biopsy CT sections were obtained at the level of the biopsy. Chest X-rays were performed at 1 and 4 h post-biopsy in all patients and were reviewed without knowledge of the CT findings. RESULTS: Pneumothorax was detected in 37 of the 88 patients. Pneumothorax was detected on CT and chest X-ray in 20 patients, on CT alone in 15 patients and chest X-ray alone in two patients. The proportion of patients with pneumothorax detected by CT was 35/88 (40%) compared with 22/88 (25%) detected by chest X-ray. The difference between detection rates was statistically significant ($p<0.05$). CONCLUSION: The frequency of pneumothorax detected by chest X-ray after CT and fluoroscopic (from the literature) fine-needle aspiration lung biopsy are similar. CT is significantly more sensitive than chest X-ray in detecting small pneumothoraces.

1530
The incidence of pneumothoraces post-transthoracic lung biopsy and subsequent management

S L Smith, K Stevens, A Manhire and M Hawley
Department of Radiology, Nottingham City Hospital, Nottingham NG5 1PB, UK

Transthoracic needle biopsy is an increasingly common procedure in the evaluation of lung lesions, having both a high diagnostic efficacy and a low complication rate. The most common significant complication is a pneumothorax, occurring in 10–35% after fluoroscopically-guided biopsy. The rate is higher for CT-guided biopsies, probably because CT is used for biopsy of more difficult lesions, for example those immediately adjacent to cardiovascular structures or the hila. Between June 1991 and June 1996, 273 fluoroscopically-guided biopsies were performed at Nottingham City Hospital. 205 of these were fine needle aspirates using a 21G needle and 68 were Trucut biopsies using an 18G needle. Inspiratory and expiratory chest radiographs were taken immediately post-procedure and at 1 h. Further films were only taken if the patient became symptomatic. Of the 273 biopsies 28 pneumothoraces (10.25%) occurred, which is well within the quoted rate in the literature of 10–35%. All pneumothoraces were demonstrated on both inspiratory and expiratory films. 27 of these were detected on the immediate chest X-ray. One with a normal immediate film subsequently became symptomatic and a film taken at 30 min demonstrated a pneumothorax. Of these pneumothoraces, 24 were managed conservatively and four required intervention, either because they were symptomatic or because the pneumothorax exceeded 50% of the volume of the hemithorax. Two required chest drains and two were aspirated. All significant pneumothoraces were detected on the inspiratory films taken 1 h post-procedure. As a result of this study it is proposed that patients asymptomatic after needle biopsy need only an inspiratory film to be taken 1 h post-procedure, the stage at which all significant pneumothoraces are detected. This would both reduce the cost to the department and minimize radiation exposure to the patient.

1540
Detection of subtle areas of decreased lung attenuation on CT with image processing

D M Hansell, F Chabat, G Z Yang, S R Desai, C Gückel, M Gibson and S P G Padley
Department of Radiology, Royal Brompton Hospital, Sydney Street, London SW3 6NP, UK

PURPOSE: Areas of decreased lung attenuation on high resolution CT (HRCT) are a feature of small airway disease, but this sign may be extremely subtle. The aim of this study was to determine whether post-processing image enhancement improves detection of this cardinal sign of small airway disease. METHODS: A single 1.5 mm HRCT section through the lower lobes of 47 patients with suspected airway disease was assessed in different formats by four observers. In addition, a minimum intensity projection (MINIP) image of five contiguous 1.5 mm sections and an expiratory CT section at the same level were evaluated. The extent (to the nearest 5%) of decreased attenuation was scored on (1) a standard inspiratory 1.5 mm section; (2) the same section with histogram modification; (3) a MINIP slab; (4) the MINIP slab with histogram modification; and (5) an expiratory 1.5 mm section at a similar anatomical level. RESULTS: The confidence with which the scores of decreased attenuation were made were greatest and equal on expiratory CT and MINIP images. Observer agreement was best for the MINIP images (mean weighted κ 0.65) and worst for the inspiratory HRCT with histogram modification images (mean weighted κ 0.38). Correlation between the extent of decreased attenuation and FEV_1 was strongest for the MINIP images ($r_s=-0.72$, $p<0.0001$) and weakest with the inspiratory HRCT with histogram modification images ($r_s=-0.60$, $p<0.0001$). CONCLUSION: The confidence with which areas of decreased attenuation can be identified is significantly increased with some forms of post-processing, notably on MINIP images. Furthermore, quantification of the extent of MINIP images improves correlation with functional indices of airflow obstruction.

1550
A CT study of the mechanism of mosaic pattern in obstructive airways disease

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PURPOSE: There are alternative explanations for the mosaic pattern of lung attenuation on high resolution CT (HRCT) images that characterizes small airways disease: raised intraalveolar

pressure causing reduced perfusion *vs* hypoxic vasoconstriction. The aim of the study was to elucidate the mechanism of the mosaic pattern in airways diseases. SUBJECTS AND METHODS: A standard bronchial challenge was performed in 22 asthmatic volunteers (20 male, two female; mean age 30.5 years, local Ethics Committee approved). Nebulized methacholin was administered in doubling concentrations. After the forced expiratory volume in 1 s (FEV_1) had fallen >35% from baseline, two HRCT sections (upper and lower zones) were obtained at full inspiration. Subsequently, FEV_1 was monitored and the subjects were randomly assigned to breathing room air ($n=8$), oxygen (5 l min^{-1}) via nasal prongs ($n=8$) or oxygen (12 l min^{-1}) via face masks ($n=6$) for 30 min. A second HRCT was then performed covering the same regions. Density measurements and histogram analysis of comparable regions of interest on the first and second HRCT were evaluated. RESULTS: The baseline FEV_1 (mean 88.8%; range 55.8 127.2%) and the spontaneous recovery from the baseline values after the challenge (mean 72.6%; range 46.13–100%) were not significantly different for all three groups. In the lower zones the subjects breathing high concentration oxygen via face masks showed a significantly higher increase in lung density on their second HRCT than the "room air" group (mean 14.8 ± 6.3 HU *vs* -1.9 ± 10 HU; $p<0.02$). A similar trend was also observed in the upper zones, although this did not achieve statistical significance ($p>0.09$). CONCLUSION: These results confirm that hypoxic pulmonary vasoconstriction, rather than raised intra-alveolar pressure, is the cause of the mosaic pattern of lung attenuation on inspiratory HRCT images.

1600

Mosaic lung attenuation on high resolution CT: differentiation between parenchymal, airway and vascular aetiologies

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Departments of Radiology, [1]Royal Victoria Infirmary, Newcastle NE1 4LP, UK, [2]Vancouver General Hospital, Vancouver V5Z 1M9, Canada, [3]Mayo Clinic, Rochester, Minnesota, USA and [4]Royal Brompton Hospital, Sydney Street, London, UK

PURPOSE: The aim of this study was to determine whether infiltrative, airway and vascular disease can be differentiated as the cause of mosaic lung attenuation on high resolution CT scans. MATERIALS AND METHODS: 70 consecutive patients with a pattern of mosaic attenuation on high-resolution CT and pathological, or clinical proof of the diagnosis presenting to each of three institutions were reviewed. The causes for the mosaic pattern included infiltrative lung disease ($n=37$), airway disease ($n=22$) and vascular disease ($n=11$). The high resolution CT findings were assessed by two blind independent observers, who had not previously seen any of the cases. RESULTS: The type of disease was correctly identified in the first choice in 58 of 70 (83%) (Observer 1) and 57 of 70 (81%) (Observer 2) cases, respectively. A correct first choice diagnosis for the type of disease was made in 34 of 37 (92%) and 34 of 37 (92%) cases of infiltrative lung disease; 21 of 22 (95%) and 19 of 22 (86%) cases of airway disease and three of 11 (27%) and four of 11 (36%) cases of vascular disease (Observers 1 and 2, respectively). CONCLUSION: Infiltrative lung disease and airway disease were usually correctly identified as the cause of mosaic attenuation. Vascular disease, however, was often misinterpreted as either infiltrative lung disease or airway disease.

1610

Regional pulmonary perfusion using electron beam CT in acute respiratory distress syndrome

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PURPOSE: Acute respiratory distress syndrome (ARDS) is characterized by bilateral pulmonary infiltrates on chest radiography, decreased lung compliance and refractory hypoxaemia. Studies using the multiple inert gas technique have confirmed that this is attributable almost entirely to shunt. In early stages of ARDS CT has revealed dense opacification in the dependent regions of the lung, reflecting compression atelectasis. Electron beam CT, which allows the evaluation of perfusion within specified regions of interest (ROI), was used to study the distribution of pulmonary perfusion in five patients with ARDS whose CT scans confirmed dependent opacification. METHODS: Repeated sections were obtained at a single level through the lower lobes, during the injection of non-ionic contrast, with respiration held in inspiration. Regions of interest were placed in designated positions on the images acquired and perfusion calculated relative to the mean perfusion of the whole slice, using accepted equations for this technique. RESULTS: Perfusion increased from ventral to dorsal regions (relative perfusion (%)±SEM: 51.9 ± 8.1; 63.0 ± 10.6; 86.9 ± 8.4; 130 ± 10.6; 165.7 ± 30.2. A striking finding was that, in regions of dependent atelectasis, levels of perfusion were not dramatically reduced and in some cases even increased (165.7 ± 30.2%), suggesting they represent areas of shunt. CONCLUSIONS: This technique has the potential to define the regional distribution of pulmonary perfusion in ARDS and may allow the effects of therapeutic interventions, aimed at manipulating the pulmonary circulation, to be evaluated.

1620

Bronchial disease in α_1 antitrypsin deficiency-related emphysema

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PURPOSE: The association of emphysema with homozygous α_1-antitrypsin deficiency (Pi Z) is well recognized. There are, however, limited radiological studies looking at the association of Pi Z with airways disease, in particular bronchiectasis. This study evaluates the incidence of bronchial wall thickening and bronchiectasis depicted on high resolution CT (HRCT) in patients with Pi Z. MATERIALS AND METHODS: HRCT scans in 59 PiZ individuals were evaluated for the presence of bronchial wall thickening and the presence and extent of bronchiectasis. Recognized criteria for the diagnoses of bronchiectasis were used. The clinical symptomatology for each patient was recorded. RESULTS: 25 of the 59 Pi Z individuals (42.4%) had chronic bronchitis on clinical criteria. Eight of these (13.6%) had evidence of bronchial disease on HRCT. Three cases (5.1%) showed bronchial wall thickening only, but the other five patients (8.5%) fulfilled the criteria for bronchiectasis. Bronchial disease was not diagnosed on CT in any individual without clinical sumptoms. CONCLUSION: Clinical symptoms of bronchial disease were a common feature in patients who are homozygous for Pi Z. A significant proportion of these were demonstrated to have bronchiectasis on HRCT scans.

1630

Chest CT in the paediatric intensive care unit—spiral or high resolution CT

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Departments of [1]Diagnostic Radiology and [2]Paediatric Medicine, St Mary's Hospital, London W2 1NY, UK

Chest CT can detect intrathoracic pathology not appreciated on chest radiograph and influence management in adult intensive care patients. The use of chest CT in the paediatric intensive care unit (PICU) is not yet established, partly due to radiation dose concerns. PURPOSE: To assess whether CT provides additional information over chest X-ray (CXR) regarding the extent and nature of intrathoracic disease in critically ill children. To determine whether such information alters clinical management and to assess the role of a low dose HRCT protocol in PICU patients. METHODS: 17 children on the PICU underwent chest CT over 30 months. The inclusion criteria were: inconclusive diagnosis from CXR; and/or CXR appearances inconsistent with ventilatory requirements. CT protocol was tailored to the clinical question. Nine spiral (120 mAs, 120kVp) and eight HRCT (50 mAs, 2/10 or 2/15 mm) scans were performed. RESULTS: In 14/17 patients CT provided additional information regarding the nature of disease. New information led to positive therapeutic intervention in six cases, prevented inappropriate therapeutic manoeuvres in four and had no significant effect on acute management in four children. CONCLUSION: Chest CT can add to the sensitivity and specificity of intrathoracic diagnosis provided by the chest radiograph and directly influence the acute management of critically-ill children. The CT protocol (spiral or HRCT) should be tailored to the clinical/radiological question. In this select group of patients non-contiguous HRCT often provides accurate assessment of pulmonary parenchymal and pleural pathology at a reduced radiation dose compared with spiral CT.

1500–1700
BIR Debate
This House Believes that the Private Finance Initiative has Failed to Achieve its Objectives
Hall 9

Moderator
S J Golding *Oxford MRI Centre, John Radcliffe Hospital, Oxford, UK*
Speakers
For the motion:
A T Carty *Royal Liverpool Hospital, Liverpool, UK*
A Maynard *University of York, York, UK*
Against the motion:
M Porte *York District Hospital, York, UK*
P Sharpe *Somerset MRI Centre, Bridgwater, UK*

1515–1645
Workshop
MRI for Radiographers—Practical MRI
Hall 10a

1515
Invited Review
Optimizing image quality
C A Westbrook
University Department of Radiology, John Radcliffe Hospital, Oxford OX3 9DU, UK
An understanding of the factors that affect image quality and their trade-offs is of fundamental importance for the optimal use of the MRI system. These factors are: contrast-to-noise ratio (CNR); signal-to-noise ratio (SNR); spatial resolution; and scan time. The CNR is arguably the most important image quality factor, as it determines the ability to distinguish one tissue from another and to discriminate between pathology and normal tissue. It is determined by the comparative SNR values between different tissues. The SNR is defined as the amplitude of the signal received in the receiver coil to the average amplitude of the noise. Various factors affect the SNR, including voxel volume, extrinsic contrast parameters (TE, TR and flip angle) receive bandwidth and the number of signal averages. Each, however, also affects spatial resolution and/or contrast and/or scan time. Spatial resolution is defined as the ability to distinguish two points as separate and distinct. It is entirely controlled by voxel volume and directly trades-off against SNR. The scan time is perhaps not immediately obvious as an image quality parameter, but if scan times are longer than patient tolerance, motion artefact is likely. This will ruin an image, regardless of its quality in terms of SNR and spatial resolution. Imaging parameters must therefore be selected with this in mind. The above image quality factors will be discussed in detail and their trade-offs and importance in clinical imaging will be evaluated.

1540
Invited Review
General anaesthesia in paediatric MRI
G Darwent
Sheffield MRI Unit, University of Sheffield, Royal Hallamshire Hospital, Sheffield S10 2JF, UK
MRI of children needs special consideration due to the problems inherent in the technique, namely, long scan times with high sensitivity to patient movement and patient refusal. Where there is a significant demand for imaging children with MRI it is therefore necessary to develop a specialized general anaesthesia or sedation protocol. Specialized MRI-compatible anaesthetic and monitoring equipment is required with dedicated paediatric accessories. It is advisable to have a team of MRI experienced personnel to perform the examinations: an MRI experienced anaesthetist, ITU technicians and a radiographer. It is vital to have good communication with paediatric wards so that nursing staff experienced with the technique are available. A protocol should be drawn up with which all the aforementioned disciplines are familiar and this should be carefully followed. Once in place, the technique will allow the production of high resolution MRI images with minimum risk to the patient. As the number of patients scanned per session is limited, waiting lists will inevitably arise and the concept of a general anaesthesia "Blitz Day" will be discussed. MRI scanning of children using general anaesthesia has been the preferred option in the Sheffield MRI Unit. However, it is recognized that sedation techniques are an alternative method in many centres and, in the hands of experienced personnel, allow a higher patient throughput. The advantages and disadvantages of both techniques will be briefly discussed, together with the clinical conditions appropriate to each.

1605
Invited Review
MR safety—current thinking
L Robinson
Hope MR Centre, Hope Hospital, Salford M6 8HD, UK
This first part of this presentation will deal with the resource material which the national MR safety committee have recommended be available in all MR departments. Access to this material should enable MR practitioners to deal with most, if not all, MRI safety problems as they arise. There will be a review of the contents of each document, along with source information. The remainder of the talk will cover popular discussion areas with regard to MR safety: pregnancy, aneurysm clips, intrauterine contraceptive devices and metallic intraorbital foreign bodies. The information given will be that which has been gleaned from review of the literature, it is in no way intended as personal recommendations for practice. As with all clinical decisions, the benefits of the examination must be weighed against the risk. This equation will clearly be very different from patient to patient. The clinician is the best person to determine the benefits of the examination, whilst the MR practitioner *must* be able to outline the possible risks. It is also important to compile a set of local rules with regard to the use of magnetic resonance. The Institute of Physics and Engineering in Medicine (IPEM) will be able to recommend a suitably qualified magnetic resonance adviser to assist you in the formulation of such a document.

1630
Discussion

1600–1700
State of the Art Symposium
Brachytherapy Biophysical Planning
Hall 10b

1600
Invited Review
Imaging, planning and biological interactions
D A Ingham
Medical Physics Department, Royal Devon and Exeter Healthcare NHS Trust, Exeter EX2 5DW, UK
The inherent conformity of brachytherapy has resulted in slow changes in treatment planning dosimetry. The tried and tested systems, *e.g.* Manchester and Paris, are still in routine use. These systems are applicator-based and do not explicity require target volume definition. To deliver a more conformal treatment, brachytherapy needs to move to imaging-based treatment planning (CT, MRI, US) with target volume and critical normal tissue definition. This, coupled with all the computer analysis currently availabe, *e.g.* volume–dose analysis, will progress brachytherapy along similar lines to external beam treatment planning. Increasing knowledge in radiobiological planning will be required to quantify the effects of different combinations of external beam and brachytherapy treatment, in both space and time. These topics will be considered in this paper.

1620
Invited Review
3D biological effect distributions in brachytherapy
[1]C Deehan, [2]N S Reed and [1,3]T E Wheldon
[1]*Department of Clinical Physics and Bio-Engineering;* [2]*Beatson Oncology Centre; and* [3]*Glasgow University Department of Radiotherapy Research, Glasgow G11 6NT, UK*
INTRODUCTION: Brachytherapy planning based on physical dose distributions alone may not reflect changes that take place in biological effects [*e.g.* linear quadratic (LQ) transformation of dose distribution] when treatment schedules are altered. These changes can only be properly evaluated if their relationship to the position of anatomical structures of interest is known. Soft tissue structures, however, are often difficult to visualize on orthogonal radiographs. Modern scanners allow CT data sets to be obtained from patients with brachytherapy applicators in place. These images can be used in 3D treatment planning systems to study the relationship between biological effect distributions and anatomical structures in a way which is not possible using orthogonal radiographs. MATERIALS AND METHODS: Patients were CT scanned with treatment applicators in place. CT images were acquired on a Philips SR 7000 series scanner and networked to a 3D treatment planning system. These were merged with a reconstruction of the brachytherapy insertion obtained from orthogonal radiographs. Biological effects distributions were generated using the LQ model and superimposed on each slice. CONCLUSIONS: 3D changes in the biological effect distribution arising from alterations in treatment schedules can be assessed in relation to individual patient anatomy using CT imaging.

1640
Discussion

Notes

Posters

National Indoor Arena Concourse Area

Abdomen

POSTER 0101
Gastroplasty for morbid obesity: spectrum of findings on upper gastrointestinal series

N Sadeghi, M Zalcman, J J Houben, D Van Gansbeke and J Struyven
Erasme Hospital, Brussels 1070, Belgium

Obesity is a major health problem in the developed world. A number of gastroplastic procedures have been developed to limit food intake in patients with morbid obesity. This exhibit illustrates the post-operative radiological aspects of patients undergoing open silastic ring vertical gastroplasty (SRVG), which is considered the treatment of choice for morbid obesity. Upper gastrointestinal series are usually performed in the early and late post-operative period. The examination technique is described. The normal post-operative appearance, as well as early and late post-operative complications, are detailed. Cardial incontinence with gastric reflux is a common finding. Early complications are stomal oedema and, rarely, perforation. Late complications consist of stomal stenosis and pouch dilatation, staple line disruption, silastic ring desertion with stomal widening, gastric pouch horizontalization and food impaction. All the radiological findings are well correlated with clinical manifestations.

POSTER 0102
Double contrast small bowel follow-through in post-gastrectomy patients

P J Papadaki, G M Zavras, D G Karakiklas, N G Kounis, K Tsagarakis and A Feretis
Department of Radiology, KAT General and Emergency Hospital, Athens 145 61, Greece

PURPOSE: To determine the diagnostic value of the small bowel follow-through examination, after *per os* administration of barium suspension and methylcellulose, when evaluating small bowel pathology in post-gastrectomy patients. MATERIALS AND METHODS: An examination of 27 post-gastrectomy patients with possible small bowel pathology was performed. (Normals 19, malabsorption four, adhesions three, neoplasm one.) The patients were given 150 ml of 70% wt/vol barium suspension, followed by 600 ml of methylcellulose. The quality of the examination itself was rated by two radiologists as "excellent", "good" or "poor". RESULTS: The study was rated as "excellent" in nine (33.3%), "good" in 16 (59.2%) and "poor" in two (7.4%) cases, respectively. High diagnostic value double contrast imaging was obtained; even in patients with delayed transit time the quality of the examination was not affected. CONCLUSION: The *per os* small bowel examination using both methyl cellulose and barium suspension is an alternative method for the study of small bowel pathology, especially in post-gastrectomy patients.

POSTER 0103
***Per os* double contrast examination of the large bowel by endogenous gas generation**

P J Papadaki, G M Zavras, D G Karakiklas, A Feretis, N G Kounis, K Vasiou and I Fezoulidis
Department of Radiology, KAT General and Emergency Hospital, Athens 145 61, Greece

PURPOSE: To eliminate the disadvantages of the conventional follow-through examination of the colon and obtain double contrast images. MATERIALS AND METHODS: We have used a method of generating endogenous gas, by *per os* administration of a mixture containing lactulose, barium sulfate and gastrographin in 67 patients with previous unsuccessful barium enema. RESULTS: Double contrast images of the colon were obtained in 64 of the 67 patients. The true positives were 30, true negatives 29 and false negatives five. There were no false positive results. In three patients the examination failed due to diarrhoea (sensitivity 85%, specificity 100%, accuracy 88%). CONCLUSION: This method may be used as an alternative investigation of the colon, especially in elderly patients who have difficulty in retaining the barium enema.

POSTER 0104
Appearances of renal cell carcinoma metastases in the pancreas using three-phase helical CT

C S Ng, E M Loyer, R Iyer, C David, R Dubrow and C Charnsangavej
Department of Diagnostic Radiology, UT MD Anderson Cancer Centre, Houston, TX 77030, USA

PURPOSE: Renal cell carcinoma (RCC) metastases to the pancreas are rare, but their accurate identification may be necessary if surgical resection is considered. This study describes the enhancement pattern on CT of RCC metastases to the pancreas. METHODS AND MATERIALS: Thin-section three-phase iv-enhanced CT scans of four patients with RCC metastases to the pancreas were evaluated. All the patients had previous nephrectomies for primary RCC and all had pathologic confirmation of the pancreatic metastases. The helical CT protocol included 3 mm collimation, 2:1 pitch, and 150 ml non-ionic contrast media (delivered at 3 ml s^{-1}), with scans at 25, 60, and 120 s through the pancreas. RESULTS: There was a typical differential enhancement pattern between the metastatic deposits and normal pancreatic parenchyma, characterized by rapid enhancement of the metastases during the arterial and portal dominant phases, resulting in differential Hounsfield attenuations (compared to normal pancreatic parenchyma) of 30–70 HU. Multifocal metastases were clearly identified on the arterial phase in two patients. The differential Hounsfield attenuations were only minor on delayed phases of scanning (10–30 HU), resulting in poorer conspicuity of the lesions. Some of the larger lesions showed central areas of low density, consistent with necrosis. CONCLUSIONS: The enhancement characteristics of renal metastases to the pancreas are such that they are most conspicuous during the early phases of scanning (the arterial and portal dominant phases), but may fail to be appreciated on delayed scans. In patients with suspected metastatic renal cell carcinoma to the pancreas, early phase scanning following iv contrast should be included.

POSTER 0105
Quantitative comparison of image quality using Endorem at 1.5 and 0.5 T

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INTRODUCTION: Due to limitations in access to a 1.5 T MRI scanner for imaging of the liver, a study was performed to ascertain whether similar diagnostic information could be obtained on a 0.5 T system with the use of Endorem, which has been demonstrated to improve lesion detection. SUBJECTS AND METHODS: Six patients were examined post-Endorem on both a 1.5 T GE Sigma Echospeed and 0.5 T GE Vectra. To obtain standard measurements upon both systems, a gel with similar T_1 and T_2 properties to liver was attached to the patient prior to the scan. Both examinations were scanned consecutively within 1 h of the end of the infusion. RESULTS: An 8 mm slice thickness was used on both systems but, in order to maintain comparative signal:noise ratios, the in-plane resolution on the 0.5 T system was 4.4 mm^2 in-plane resolution compared with 2.5 mm^2 on the 1.5 T system. There was no significant difference in the lesion:liver contrast ratio between the two systems. Examination time varied on the 1.5 T system; respiratory triggering was used which significantly reduced ghosting. The difference in image quality between the systems was markedly different on the initial patients, however, the recent introduction of phase-ordered compensation on the 0.5 T system has largely eliminated this difference. CONCLUSION: In each patient the axial T_2 weighted FSE images demonstrated the characteristic decrease in signal intensity of normal liver tissue due to the uptake of super paramagnetic iron oxide particles. In all cases, all lesions identified at 1.5 T were also present on the 0.5 T images.

POSTER 0106
Dynamic γ-scintigraphy in the evaluation of peritoneal resorption and regional sorption detoxication in peritonitis model

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PURPOSE: Using dynamic γ-scintigraphy to study peritoneal resorption and its correction by regional sorption detoxication in diffuse purulent peritonitis. MATERIALS AND METHODS: After contamination of the abdominal cavity of dogs ($n=18$) with bacterial-isotope complex (live culture *E. coli* O_{151} labeled with $^{99}Tc^m$ pertechnetate), dynamic γ-scintigraphy was immediately started and included radiometric and measurement of bacteriological contamination of blood and peritoneal exudate. Radiological evaluation of regional sorption detoxication efficacy was performed by infusion of bacterial-isotope complex into the abdominal cavity of dogs ($n=6$) after placing sorbent in the subphrenic space. RESULTS: Time of maximum blood level of bacterial-isotope complex (45–120 min) was correlated with the highest radioactivity level in the left subphrenic space. The sites of the greater accumulation of bacterial-isotope complex were left and right subphrenic spaces and the left lateral channel. In regional sorption detoxication, the highest level of radioactivity was registered in the projection of the sorption composition,

radioactivity in extra abdominal foci lowered ($p<0.01$). CONCLUSION: Dynamic γ-scintigraphy allows the study of peritoneal resorption and evaluation of the efficacy of new and routine regional sorption detoxication methods in diffuse purulent peritonitis.

Audit

POSTER 0201

Pelvic CT planning audit

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PURPOSE: We have recently begun CT planning of the pelvis and have undertaken an audit of the planning process with the aim of identifying any systematic errors in positioning. MATERIALS AND METHODS: A pelvis phantom was set up in the CT scanner with lateral and midline markers and a set of scans obtained. These were transferred to the treatment-planning system, where a pelvis volume was outlined and then planned. The treatment plan was written-up and simulated. An anteroposterior (AP) and lateral film were taken, focus-to-skin distances and separations measured. The simulator films were scanned into the treatment planning system and overlaid with a Beam's Eye View (BEV) of the bony anatomy to judge positional errors. RESULTS: The couch in the CT image appeared to have a right-left tilt of about 0.3 cm. The lateral marks appeared to be horizontal with respect to the image. In the simulator, the lateral marks differed in height above the couch by 0.5 cm. The AP simulator film showed a small right/left shift; the lateral film had a 0.3 cm shift in the AP direction. CONCLUSIONS: Although the magnitude of the errors found was not large and would be considered acceptable for patient treatment of the pelvis, slightly better had been anticipated under optimum conditions. It is clear that the most likely cause of the AP shift was the tilt in the CT couch, caused either by a real tilt or a rotation in the CT frame. Further work is underway to identify and eliminate this problem.

POSTER 0202

Collaborative approaches to clinical audit in radiation oncology; a review of issues in undergraduate research

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This paper gives the background to the increase in undergraduate (UG) research projects undertaken as a result of the implementation of Working Paper 10 which resulted in the change from diploma to degree preregistration training for radiographers in the UK. PART 1: An overview of a number of recent projects, undertaken by students which have resulted in improvements to the service for patients receiving radiotherapy at the Leicester Royal Infirmary NHS Trust. PART 2: A discussion of other positive outcomes pertaining to collaborative research, including the impact upon continuing professional development (CPD) for clinical staff and implications for postgraduate training in radiotherapy. The management of UG projects as a valuable clinical resource, in providing an evidence-based approach to clinical practice via a collaborative approach to clinical audit, is also discussed. PART 3: Problem areas will be explored, based upon the authors' accumulated experience. These will include ethical issues, planning and supervision of projects, as well as data collected from UG students. PART 4: Some potential solutions are suggested. A number of recommendations will be made relating to lessons learnt, as well as points raised for further debate. These relate to the changing needs of the service, where the predominant culture within the clinical environment continues to evolve, from one formerly based on precedence, to one increasingly based on evidence.

Breast

POSTER 0301

Prevention of glandular tissue under-exposure in mammographic screening

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PURPOSE: Mammographic detection of early-stage breast cancer demands an adequate optical density of dense structures in mammograms. It is therefore essential that the imaging system is stable and produces an appropriate film density level. The exposure technique should be adapted to the composition and location of glandular tissue in the breast. A method of approach is presented to set standards for the minimum optical film density of phantom images and mammograms, to prevent under-exposure of the glandular tissue. MATERIALS/METHODS: The stability and exposure level of the imaging system is controlled daily in the Dutch screening programme, by means of light sensitometry and phantom imaging. The relation between phantom image density, mammographic optical density and the radiologist's assessment of mammogram image quality, with respect to the exposure level, was investigated for 574 mediolateral oblique mammograms, obtained from six screening units. RESULTS: In the Dutch screening programme, the majority of the mammograms appeared to be adequately exposed at AEC settings corresponding with a phantom image density of $\geqslant 1.2$ OD. Extra attention should be given to mammograms with dense glandular tissue, where increase of the exposure level might be necessary. In general, the minimum optical density of the glandular tissue should be >0.8 OD to be assessed as adequate. CONCLUSION: Under-exposure of glandular tissue can be prevented by complying with a standard for the film density level and adaptation of the exposure technique to the composition and location of glandular tissue in dense breasts.

POSTER 0302

The advantages of synchrotron radiation for breast imaging

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The conventional X-ray set which is used to produce the radiation for almost all diagnostic imaging has changed remarkably little in almost 100 years. Most of us are therefore accustomed to thinking about X-rays in a certain manner which is constrained by the limitations of the source. Synchrotron radiation is a very different way of producing X-rays, which removes many of the limitations of conventional sources and consequently makes possible new and novel techniques. Its unique combination of properties allows substantial dose reductions over conventional sources and images of vastly superior quality are obtained. In mammography the potential improvements are quite spectacular and, after a brief introduction to synchrotron radiation, these possible benefits will be discussed.

POSTER 0303

Quality control in the Dutch breast cancer screening programme: a review of the 1995/96 test results

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PURPOSE: Technical quality control tests within the Dutch breast cancer screening programme are performed by the National Expert and Training Centre for Breast Cancer Screening. In this presentation, the 1995/96 test results (201 tests) are reviewed and evaluated. METHODS AND MATERIALS: The measurements were performed according to the "Protocol for Acceptance Inspection of Breast Cancer Screening Units, version 1993". For all test items, rates of non-acceptance have been determined and three categories of non-acceptance have been defined: category one: <5%, category two: 5–20% and category three: >20%. RESULTS: A decrease in the non-acceptance rate has been observed for sensitivity and absorption of cassettes, compression force (both switched to category two), darkroom light tightness (>10% decrease, remained in category three) and kV compensation (about 10% decrease, remained in category two). An increase has been observed for view box illumination (>10% increase, remained in category three) and tube voltage settings (>5% increase, switched to category two). CONCLUSION: Regular testing showed high non-acceptance for a number of test items. Subsequent contact with manufacturers led to adjustments and modifications of equipment. However, for some items, the non-acceptance remained high. It is expected that for a number of these items the non-acceptance rate will decrease in the near future, due to recent modifications and replacement of equipment. For two items the non-acceptance increased significantly, actions need to be taken to lower these rates.

POSTER 0304

Fibroadenomatoid hyperplasia: another cause of suspicious microcalcifications at mammographic screening

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INTRODUCTION: Fibroadenomatoid hyperplasia (FAH) is a well-described, benign breast lesion. The radiological features of FAH have never been previously described. Several pathology reports of FAH in biopsies of screen-detected microcalcification prompted this study. METHODS: Two experienced breast pathologists reviewed all screening-provoked core biopsy and surgical specimens, where the original report contained fibroadenoma of FAH, to identify cases of FAH. The site of any calcification present histologically was also documented. The mammographic features of FAH cases were documented by the two radiologists. RESULTS: 11 cases of FAH were identified in nine core biopsies and two surgical specimens. Calcification was present pathologically in 100%. Calcification was stromal in nine, subepithelial in two and epithelial in none. The mammographic features of FAH are granular microcalcifications which vary in shape, size and density, without an associated mass (100%). These calcifications were in a localized, irregularly-shaped cluster in 91%. Rod-shaped calcifications were seen in 61%. CONCLUSION: FAH is a cause of suspicious microcalcification at screening mammography. FAH can be confirmed using 14 g core biopsy in most cases.

POSTER 0305

BRCA 1: a comparison of Wolfe mammographic parenchymal patterns of 1294de140 mutation carriers and non-carriers in a single family

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The BRCA 1 gene is associated with an increased risk of breast and ovarian cancer. This study aimed to identify if there was any obvious difference in mammographic density between carriers and non-carriers in an affected family group. The mammograms of 15 females, within a family with a mutation in the BRCA 1 gene, were assessed by two radiologists, using Wolfe's classification for parenchymal pattern. (N_1, P_1, P_2, DY) P_2/DY patterns have been associated with an increased risk of breast cancer. Seven individuals were carriers [mean age 39 years, standard deviation (SD) 5.4, range 31–44 years] and eight were non-carriers (mean age 40.3 years, SD 11.0, range 27–64 years) for the 1294de140 mutation. The study has insufficient power to demonstrate significant phenotype–genotype association with Wolfe patterns in the BRCA 1 positive and negative groups. However, there is a slight preponderance of the more dense patterns P_2/DY in the carriers (four out of seven) compared with non-carriers (three out of eight). No significant difference in the subjective change in mammographic density was shown. A larger study, combining results from several families, would be required for further evaluation of this finding.

POSTER 0306

Invasive breast cancer: mammographic US measurements

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PURPOSE: To establish the degree with which estimates of tumour diameter, determined by mammographic and ultrasonographic methods, correlate with actual tumour size. MATERIAL AND METHODS: A prospective study of 41 women, aged 28–73 years with invasive breast cancer was undertaken. Tumours were measured mammographically and ultrasonographically in the week preceding surgery. Mammographic tumour size was determined as the largest dimension observed on any mammographic projection (craniocaudal, lateral, mediolateral oblique) while ultrasonographic tumour size was determined by the maximum diameter demonstrated. These measurements were subsequently compared with the largest tumour dimension in the gross specimen. RESULTS: The relationship between mammographic size and pathological size was 1.1 : 1 with low variability. Similar results were obtained when comparing ultrasonographic and pathological size. Four tumours had diffuse mammographic outlines and could not be measured and three were either not assessable or incorrectly assessed by both techniques due to diffuse infiltration of breast. CONCLUSION: Mammography and US can allow tumour size to be measured accurately and can be used as an alternative when pathologic staging is not possible. Ultrasonography is especially useful in monitoring the response of breast tumours to treatment.

POSTER 0307

Measurement of breast tumour diameter by magnetic imaging and mammography: comparison with histology

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PURPOSE: Accurate measurement of the size of breast tumours is important in assessing prognosis and in planning treatment of invasive breast cancer. This study reports the accuracy of MRI and mammography, in determining the maximum breast cancer diameter, in comparison with histopathological measurement. MATERIALS AND METHODS: 24 breast cancers from 22 patients, aged 33–78 years (mean = 56 years), were examined with mammography and MRI. All patients underwent both craniocaudal and mediolateral oblique mammograms. Dynamic contrast enhanced T_1 weighted 3D images of the breast were acquired on a 1.5 T MRI scanner (Philips Medical Systems). Digital subtraction was performed on all post-contrast images. Mammography and MRI were performed by different observers and compared with the largest tumour diameter found at pathological examination. All observers were blinded to the others' results. RESULTS: At histology the maximum tumour diameter was in the range 12–40 mm (mean 21.2 mm). The correlation between histological size and mammographic diameter, and between histological size and MRI tumour diameter was low ($r = 0.14$ and 0.27, respectively). There was also a lack of correlation between MRI and mammographic sizes ($r = 0.37$). CONCLUSIONS: The findings of this ongoing study show poor correlation between histological tumour size and imaging measurements. This has significant implications for using imaging methods to estimate tumour size to determine prognosis and plan treatment of invasive breast cancer.

POSTER 0308

Pitfalls of breast MRI

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PURPOSE: To discuss the imaging pitfalls inherent to breast MRI. METHODS: Imaging pitfalls associated with over 400 consecutive breast MRI examinations have been collected. Examples have been selected to illustrate particular areas likely to cause interpretative difficulty. RESULTS: Imaging pitfalls associated with breast MRI broadly fall into two groups. Technical pitfalls may be patient related (*e.g.* patient habitus, claustrophobia), machine related (*e.g.* artefacts, poor fat suppression) or related to image post-processing. All may lead to misinterpretation. The second group relates to misinterpretation of imaging findings in the absence of technical problems. These may include physiological factors (*e.g.* menstrual cycle, pregnancy), unfamiliarity with diagnostic criteria leading to false positive results and interpretation of examinations post-treatment (surgery, radiotherapy, chemotherapy). Included in this group are problems of histopathological correlation. CONCLUSION: Appreciation of pitfalls associated with breast MRI should be helpful in interpretation of these examinations.

POSTER 0309

Can contrast-enhanced MRI differentiate skin recurrence from radiotherapy changes in breast cancer?

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PURPOSE: To identify whether the MRI appearances of radiation changes in the nipple and skin of patients with treated breast cancer differ from recurrent/metastatic disease to the skin. PATIENTS AND METHODS: The MRI scans of 37 women who had undergone conservation surgery and radiotherapy for breast cancer, a year or more before the scan, were retrospectively reviewed. Scans were made at 1 or 1.5 T using a dedicated double breast coil. High resolution 3D T_1 weighted gradient echo images were acquired before and after enhancement with Gd-DTPA. The morphology and enhancement patterns of the nipple–areolar complex and the skin were assessed and compared with the contralateral breast. Results were correlated with histology in 26 patients who underwent biopsy or further surgery following the MRI scan. All patients were followed-up clinically for a median of 14 months (range 1–36) following the scan. RESULTS: The scans of 27 patients showed changes of skin thickening ± nipple distortion, but with either linear

or no enhancement of the skin, these changes were attributed to radiotherapy effects. Five patients had local recurrence in the skin or nipple. In addition to skin thickening and distortion, these patients showed focal nodular enhancement. Five patients had normal appearances of the skin and nipple. CONCLUSIONS: In this small series, the skin and nipple changes occurring in the breast after radiotherapy could be distinguished from those of local tumour recurrence or metastases.

POSTER 0310

MRI appearances of the reconstructed breast

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PURPOSE: To delineate the MRI appearances of post-mastectomy breast reconstructions and to evaluate MRI in women with symptoms related to breast reconstruction. METHOD: 29 reconstructed breasts were imaged in 25 women who had undergone prophylactic or therapeutic mastectomy for carcinoma. A combination of 2D STIR, spin echo and T_1 weighted 3D FLASH sequences ± gadolinium DTPA were obtained at 1.0 T, dependent on the clinical setting. Imaging features of three types of reconstruction were noted: subpectoral dual chamber tissue expander prosthesis (TEP: $n=17$), latissimus dorsi (LD) myocutaneous flap plus prosthesis ($n=8$) and transverse rectus abdominis myocutaneous (TRAM) flaps ($n=4$). 11/25 symptomatic patients were evaluated to identify a cause for their symptoms. RESULTS: Subpectoral TEP are readily distinguishable from flap reconstructions. Imaging features include: saline/silicone-filled chambers; silicone shell irregularity, due to under-filling; and artefact from filling port. Myocutaneous flap appearance varies, depending on the orientation of the muscular component. Atrophy of the muscular component is frequently seen. Surface marking of surgical scars aids identification of flap/native-tissue interfaces. 9/11 symptomatic patients had symptoms related to normal components of the reconstruction. 1/11 had histological confirmation of fat necrosis. In 1/11 a well-defined enhancing nodule is undergoing follow-up. CONCLUSION: MRI provides excellent delineation of the reconstructed breast. Knowledge of the type of surgery performed aids interpretation. MRI is useful in evaluating symptoms related to the reconstruction.

POSTER 0311

Initial experience of general surgical procedures in an interventional MRI unit

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PURPOSE: Interventional MRI (IMR) units produce unique opportunities for image-guided surgery. Intra-operative MRI may give the surgeon information not visible from inspection alone. Potential advantages include confirmation of tumour excision and clarification of complex anatomy. There are no reports of general surgical procedures performed in an IMR unit. This study reports our initial experience with procedures on the breast, soft tissues and abdomen in such a unit. METHODS: After preliminary work to develop MRI compatible instrumentation and safe surgical techniques, 30 patients (median age 49 years, range 19–81) underwent operations in a 0.5 T General Electric Signa IMR. All procedures were performed under general anaesthesia using MRI compatible equipment. 21 breast lesion excision biopsies, one simple mastectomy, four soft tissue tumour excisions, two hemicolectomies and two laparoscopic cholecystectomies were performed. Instruments were of titanium alloy, aluminium or plastic. An ultrasonic scalpel was used for dissection and haemostasis. Flexible transmit/receive coils were placed over the relevant anatomical area and the procedure was performed through the centre. A number of imaging techniques were used for intraoperative guidance and to confirm tumour excision where relevant. Intraoperative MRI cholangiography (MRC) was attempted using T_2 fast spin echo (FSE) sequences in the patients undergoing laparoscopic cholecystectomy. RESULTS: All operations were successful and no surgical complications were met. Breast and soft tissue lesions were identified with pre-operative imaging. Intraoperative imaging visualized resection margins and confirmed complete excision. The colonic lesions (one adenoma, one carcinoma) were visualized pre-operatively with contrast-enhanced techniques, but intraoperative imaging of the lesion and associated lymph nodes was poor. The gall bladder and part of the extrahepatic biliary tree was demonstrated with intraoperative MRC in the laparoscopic cholecystectomies. CONCLUSION: This preliminary study demonstrates that a variety of general surgical procedures are now possible in the IMR. Intraoperative imaging is of good quality for breast and peripheral soft tissue lesions and can guide tumour excision, but is poor for abdominal procedures. Further work is required to develop imaging techniques for abdominal surgery and define the indications for this form of image-guided surgery.

Cardiovascular System

POSTER 0401

The radiological appearances of primary cardiac lymphoma

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INTRODUCTION: Primary cardiac lymphoma (PCL) is defined as an extranodal lymphoma confined to the heart and pericardium. The majority of cases are diagnosed at post-mortem. We describe two cases of PCL demonstrated on CT and MRI. We discuss a third case with secondary cardiac lymphoma. MATERIALS: Both patients with PCL presented with pericardial effusions containing lymphoma cells. The third patient was found to have secondary cardiac involvement during mediastinal relapse of non-Hodgkin's lymphoma. RESULTS: MRI of the first patient showed nodular, lobulated thickening of the inferior right ventricle (RV) wall and inter-ventricular septum, extending around the pulmonary outflow tract and the aortic root and encasing the right coronary artery. Helical CT of the second case demonstrated involvement of the right heart, with focal irregular thickening of its anterior surface, extending to the aortic root and encasing the right and left coronaries. The patient with secondary cardiac involvement underwent CT and MRI, which showed lobulated thickening of the RV wall and pericardium, associated with mediastinal adenopathy. CONCLUSION: Both cases of PCL show nodular ventricular wall thickening. The literature records a similar right-sided predilection. Encasement of the coronary arteries may be seen. Secondary cardiac lymphoma may not differ markedly in appearance, although mediastinal disease is often present. MRI gives a clearer demonstration of pathology without contrast and may allow follow-up assessment of response and wall thickness.

POSTER 0402

The development of an MRI protocol for the investigation of patients with suspected right ventricular dysplasia

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PURPOSE: To develop an MRI protocol for the exclusion of RV dysplasia using criteria of RV morphology, fatty infiltration and RV wall motion abnormalities. METHODS: 40 patients have been imaged with ECG triggering on a 1.5 T Philips ACS NT clinical MRI system for both anatomical and functional assessment of the RV wall and outflow tract. Anatomical imaging was performed with the patients either prone or supine, using either the body rf coil or a circular surface coil and a minimum of two of the following optimized pulse sequences: (i) T_1 weighted spin echo (SE); (ii) T_1 weighted SE planar imaging (SE-EPI) with an EPI factor of three; (iii) T_2 weighted turbo spin echo (TSE); or (iv) breath-hold, black-blood pulse sequence using double inversion prepulses. Functional imaging was performed at multiple axial levels and heart phases with a circular surface coil and the patient supine using a breath-hold, segmented κ-space gradient echo pulse sequence and a breath-hold myocardial tagging pulse sequence. RESULTS: The best demonstration of RV free wall and outflow tract anatomy was achieved with the patient prone on the surface coil, using the optimized T_1 weighted SE pulse sequence. Comparable image quality was also obtained using the breath-hold black blood pulse sequence. The use of myocardial tagging improved confidence in the identification of wall motion abnormalities. CONCLUSION: An MRI protocol has been developed which provides images of the consistently high image quality required for both anatomical and functional assessment of the RV wall for the diagnosis of RV dysplasia.

POSTER 0403

The management of blunt thoracic aortic trauma without angiography: the emerging role of spiral CT

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INTRODUCTION: Angiography is the current "gold standard" for investigating suspected traumatic thoracic aortic disruption; its relative invasiveness is set against the high penalty of missing a potentially fatal injury. Spiral CT has recently been proposed as a less invasive and more widely available alternative to angiography; it images the aorta directly and can detect or exclude aortic injury accurately. A pictorial review of the diagnostic features of thoracic disruption seen with spiral CT is presented; recognition of these should make confirmatory angiography unnecessary. METHODS: Six cases of thoracic aorta disruption secondary to blunt trauma are reviewed. Four children, included from a previous study at The Hospital for Sick Children, Toronto, (age range 7–15 years, all male) underwent both contrast-enhanced spiral CT and arteriography; in all four, the site and extent of injury was diagnosed by CT, with aortography contributing no further information. Two adult males (ages 30 and 40) underwent surgery after spiral CT findings alone, with good correlation between operative and CT findings. RESULTS: Injuries sustained were one small intimal tear, four pseudoaneurysms, (three at the isthmus, one at the level of the left atrium and one avulsion at the origin of the right subclavian artery); their features will be illustrated. CONCLUSIONS: A confident diagnosis of blunt thoracic aortic disruption can be made using spiral CT. Confirmatory angiography not only is unnecessary, but also may waste valuable time and should be reserved for situations when CT finding are not adequate to exclude injury.

POSTER 0404

Diagnosis of aortic coarctation and assessment of post-operative repair using MRI

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19 patients (14 male and five female, aged 23–57 years, average 38 years) were studied with MRI; nine with suspected coarctation and 10 following surgical repair (2–38 years post-surgery). In the nine patients with clinically suspected coarctation, MRI demonstrated the morphological appearance of the coarctation and assessed secondary features – collateral circulation, left ventricular hypertrophy and post-stenotic dilatation. The aortic narrowings ranged from localized webs and tubular narrowings, to complete aortic interruption. One patient was found to have a coarctation in the supra-diaphragmatic region. Gradient-echo cine sequences provided semiquantitative measurement of the functional narrowing through the coarctation. Newer velocity-encoded phase contrast sequences allowed accurate assessment of (a) the blood peak velocity passing through the coarctation (using in-plane measurement) (range 0.9–3.4 $m\,s^{-1}$) from which the pressure gradient was derived, and (b) the total volume of blood flow through the aortic narrowing and at the level of the diaphragm (using through-plane measurement) to assess contribution of the collateral circulation. Review of the 10 post-operative patients demonstrated marked narrowing, with significant gradients (up to 45 mmHg), at the repair site in four. Two had post-stenotic dilatation of the aorta and one had a clinically unsuspected 6.5 cm dilatation of the aortic root. In two patients high flow velocities (3.9 and 4.4 $m\,s^{-1}$) across stenotic bicuspid aortic valves were demonstrated. MRI of aortic coarctation provides unique anatomical and functional information. It is the primary imaging modality in diagnosing aortic narrowings, but also has an important role in the post-operative assessment of repair.

POSTER 0405

Imaging the post-operative thoracic aorta—normal anatomy and pitfalls

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PURPOSE: Following surgical repair or replacement of the thoracic aorta, interpretation of the CT and MRI scans of the thorax can be confusing. We aim to clarify some of the variations in anatomy seen after surgery. MATERIALS AND METHODS: In a 3 year period, 110 post-operative patients attending a regional thoracic aortic clinic have been imaged by CT or MRI to assess any possible complications and to document appearances for future comparison. All imaging studies were reviewed retrospectively, in conjunction with details of surgical procedures. RESULTS: The majority of surgical procedures ($n=72$) involved the ascending aorta, aortic root or arch, because of aneurysm or dissection. Repair or replacement of the various components of the aorta are performed using either prosthetic grafts or homografts. The remaining patients either had repair of leaking descending aortic aneurysm, or replacement of extensive thoraco–abdominal aneurysm. Images are presented illustrating the appearance of the thoracic aorta following a variety of surgical procedures. Some of these may suggest complications or pathology. Potential pitfalls in interpretation are discussed. These include pseudo-dissection on axial images, following elephant trunk procedures, and apparent aneurysm at the site of eccentrically-placed graft anastomoses. CONCLUSION: Images of the post-operative thoracic aorta can be misleading. All radiologists involved in interpretation should be aware of the variety of appearances that can be encountered.

POSTER 0406

The use of gadolinium-enhanced magnetic resonance angiography in assessing vascular stenoses

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PURPOSE: To study the role of gadolinium-enhanced magnetic resonance angiography (MRA) in identifying vascular stenoses. METHOD: A prospective study of patients with suspected arterial or venous stenoses. All patients underwent gadolinium-enhanced 3D breath-hold MRA on a 1.5 T Siemens scanner. 20 ml gadolinium was injected and images acquired over a 24 s sequence at a time determined by a timing run. MIP and MPR reconstructions are undertaken to produce angiograms. RESULTS: 16 patients have been imaged. The following vascular stenoses have been identified: four renal artery, one renal artery (transplant kidney), one brachiocephalic artery, two subclavian artery, one subclavian vein, one subclavian artery aneurysm, one iliac artery occlusion. A number of patients have undergone formal angiography and angioplasty to date and correlative images will be presented. CONCLUSION: Gd-enhanced MRA is a useful method of identifying vascular stenoses and can be particularly useful in imaging renal artery stenoses as nephrotoxic contrast medium is not required.

POSTER 0407

Spiral CT of intracranial and extracranial arterial vessels: 3D SSD and MIP rendering images

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PURPOSE: To assess the diagnostic accuracy of spiral CT angiography in the evaluation of intra- and extra-cranial arterial pathology. Results were correlated with other non-invasive (MRI, US) or invasive (digital angiography) techniques. MATERIAL AND METHODS: 35 patients (21 male and 14 female) with proved intracranial or extracranial arterial pathology were retrospectively evaluated. Age range was 21–67 years (mean age: 58 years). Cervical vessels were evaluated from the superior edge of C6 to the suprasellar plane to include the common carotid artery, carotid bifurcation and the internal carotid artery with its branches, including Willis circle. Scan parameters were as follows: 120 Kv, 200 mA, 512 × 512 matrix, section thickness 2 mm, pitch 1.5. Intracranial vessels were evaluated from the inferior edge of the sella to the middle region of the lateral ventricle, with gantry tilted to the orbito–meatal plane to include the posterior vertebrobasilar axis and the anterior carotid arteries axes. Scan parameters were as follows: 120 Kv, 200 mA, 512 × 512 matrix, section thickness 2 mm, pitch 1 : 1. The 2 mm sections were reconstructed at 1 mm increment, 100 ml of a non-ionic contrast material (370 mg iodine per 100 ml) were mechanically injected at a rate of 3 $ml\,s^{-1}$, with a scan delay of 20 s. SSD and MIP rendering images were obtained in all cases. RESULTS: 23 cases of anomalous course and 68 stenoses were detected. Spiral CT images were comparatively examined with US, angio-MRI and SDA images. CONCLUSIONS: Spiral CT is a highly sensitive technique for the evaluation of cervical and intracranial vessels pathology. SSD reconstructions and MPVR with MIP rendering represent an important diagnostic tool providing information about vessels course and degree of stenosis. The short time required to complete helical acquisition (about 30 s) make it possible to minimize movement artifacts even in poorly cooperating patients, with minimal invasivity.

POSTER 0408

The "Rim" sign in MRI of popliteal aneurysms

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PURPOSE: To evaluate the MRI characteristics of popliteal aneurysms. MATERIALS AND METHODS: The MRI features of three patients with histologically-proven popliteal aneurysms were

evaluated. All had presented with clinically suspect soft tissue sarcomas. RESULTS: The aneurysms had a lobulated/elliptical shape, ranged in size from 12–19 cm and were located in the upper popliteal fossa. Two were well-defined and the other ill-defined medially, due to surrounding oedema. All three displaced the surrounding musculature and were contiguous with posterior femur. In one case there was erosion of the femoral cortex and marrow oedema. All lesions were inhomogeneous on both T_1 weighted and T_2 weighted sequences, with the central components displaying mainly low signal intensity (SI) (*cf* muscle) due to haemosiderin and, to a lesser extent, high signal intensity (SI) due to subacute blood (methaemaglobin). Peripherally, parts of the rim (two cases) or the whole rim (one case) displayed low SI on T_1 weighted and very high SI on T_2 weighted sequences, in keeping with fluid. In one case following iv Gd-DTPA, high SI was noted in the central lumen, as well as around the lumen, due to intra-lesional leaks. CONCLUSION: Large popliteal aneurysms may present as soft tissue pseudo-tumours. The MRI characteristics vary with the morphology of the lesion, including the relative amounts of haemosiderin and subacute blood, as well as the presence of a residual lumen. The "rim" sign representing fluid around parts or all of the aneurysm was present in all three cases and is highly suggestive of the diagnosis.

POSTER 0409

Study to compare the differences in radiation dose and iv contrast dose between two angiographic techniques

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PURPOSE: To determine whether there is any difference in procedure time, contrast dose, radiation dose and image quality between digital subtraction angiography (DSA) and bolus chase angiography (BC) for the investigation of peripheral vascular disease. METHOD: 75 patients undergoing angiography for peripheral vascular disease were randomized to be examined by BC or DSA. Patient dose was recorded by using the integral dose–area product meter in the angiographic unit. Staff dose was recorded using the Siemens electronic personal dose meter worn outside the lead gown at neck level. Image quality was estimated from the processed angiograms, a consensus score being agreed by two observers for each anatomical region. RESULTS: No significant difference was found in age, weight, sex, symptoms, ease of catheterization, examination time or fluoroscopic screening time between the two groups. Patients undergoing BC received significantly more contrast than those undergoing DSA (29.8 g I_2 compared with 25.3 g I_2; $p=0.003$). The fluoroscopic dose received by the patients was similar in the two methods but DSA was associated with a marked increase in the acquisition dose (DSA 743 dGy cm^{-2}; BC 245 dGy cm^{-2}; $p<0.001$). There was no difference in the dose received by the members of the angiographic staff. The techniques produced similar quality images in the aorta and iliac vessels. However, DSA produced better images of the infrainguinal vessels than BC. CONCLUSIONS: DSA produces significantly better images of the infrainguinal vessels than BC, but with a higher radiation dose. DSA is the preferred investigation, although younger patients with predominantly proximal disease may be examined with BC.

POSTER 0410

Different patterns of intravascular cardiograph enhancement on helical CT

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With modern fast CT scanners, dynamic information can be obtained from different patterns of vascular enhancement. We present four cases with different patterns of inferior vena cava (IVC) enhancement from different aetiologies. *Case 1*: 28-year-old man with Marfans syndrome and dilated cardiomyopathy, demonstrating hepatic intravascular cardiograph (IVC) enhancement from functional tricuspid reflux, with no enhancement of the infrahepatic IVC. It is important to recognize this pattern as, in conjunction with a hetrogenous liver, it gives a diagnosis of a congested liver. An infiltrative process can also give a similar appearance to the liver and recognizing this pattern will avoid unnecessary liver biopsy. *Case 2*: 67-year-old man with recurrent pulmonary emboli and right heart failure, with an aortic aneurysm demonstrating a distended IVC, with iso-enhancement to the aorta representing an aorto–caval fistula. The paradoxical emboli were from the aortic mural thrombus. *Case 3*: Pseudo-filling defect within the IVC at the level of the renal vein entry, caused by mixing of enhanced blood from the kidneys with unenhanced blood from the lower body. *Case 4*: A true filling defect in the IVC and left renal vein, with neovascularization of the filling defect representing tumour thrombus within the IVC and renal vein, from a renal cell carcinoma.

Central Nervous System

POSTER 0501

Paediatric cerebral magnetic resonance angiography: a review of 34 cases

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PURPOSE: To review all the paediatric magnetic resonance angiograms (MRA) performed in a regional centre over an 18 month period. To identify reasons for referral and diagnosis, and to compare, where possible, with conventional digital subtraction angiography. METHOD: All the MRA scans performed over an 18 month period were reviewed. A Philip's 1.5 T scanner using a 3D time-of-flight sequence was used for the angiograms. All the angiograms and notes on the paediatric sub-group were reviewed. The reason for referral, diagnosis and result of the scan were assessed. Where possible, the results were compared with the results of conventional digital subtraction angiograms. RESULTS: Over the 18 month period, 370 MR angiograms were performed, 34 (9%) on children, 21 of whom were male. The most common referral was hemiplegia. Seven children with permanent hemiplegia were scanned and abnormality was identified in four cases. Three children with a history of a transient hemiplegia all had normal angiograms. Five children with atypical migraine or headaches were examined, all had normal angiograms. Five children with a clinical diagnosis of Moya Moya were imaged, four had abnormal angiograms. Four children with papilloedema were imaged, with normal angiograms in three and superior sagittal sinus thrombosis diagnosed in the last. Other, less common, indications included the possibility of a vein of Galen aneurysm, haemangioma Pfeiffer's syndrome and history of confusion. Conventional angiograms were performed in eight of the cases. CONCLUSION: MRA in children is a non-invasive method of imaging both the arterial and venous systems. It provides the diagnosis with greatest frequency in the presence of focal neurological deficit or known vasculature disease.

POSTER 0502

Withdrawn

POSTER 0503

Use of adiabatic inversion pulses to improve CSF suppression achieved by FLAIR sequences at the base of the brain

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PURPOSE: FLAIR sequences can fail to suppress CSF in the posterior fossa and this may reduce the sensitivity of this sequence. The nature of this problem has been investigated and a more robust sequence variant developed. METHOD: All studies were conducted on a Picker 1.0 T HPQ system. To exacerbate the problem, subjects were deliberately positioned suboptimally, with only the top of their heads inside the head transmit–receive coil. This identified rf inhomogeneity as a cause of the poor CSF suppression, FLAIR sequences incorporating rf tolerant adiabatic inversion pulses were then developed. These were tested on phantoms, normal volunteers and patients. RESULTS: Impaired CSF signal suppression was seen in volunteers and patients and was identified as being associated

with the edges of the regions of sensitivity of the rf coil. The use of adiabatic inversion pulses produced robust CSF suppression in all subjects. CONCLUSION: FLAIR sequences can be made more robust and provide high contrast T_2 weighted images of the posterior fossa, with effective CSF suppression, when adiabatic inversion pulses are employed.

POSTER 0504

Creutzfeldt-Jacob disease biopsy by MRI stereotactic based localization

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PURPOSE: The detection and localization of diffuse and more nearly focal Creutzfeldt Jacob disease (CJD) lesions by MRI is a rapidly-developing area of interest. The extension of this scanning technique, to permit high precision stereotactic localization of such lesions for biopsy, has been undertaken. MATERIALS AND METHODS: Phantom and patient-based studies were used to evaluate and optimize sequences which would permit the ready and appropriate imaging of both the lesions and T_2 weighted rod contents of a radionics stereotactic frame. Rigorous studies are reported on the use of spin echo (SE), fast spin echo (FSE) and, in particular, fast field echo (FFE) techniques for the simultaneous optimization of lesion contrast to noise ratio (CNR), together with maximization of accuracy in stereotactic localization. All pulse sequences have been specifically developed for the purpose, using a 0.5 T Philips T5-NT MRI scanner at London Bridge Hospital. The FFE sequences, which are critical to the procedure, have been designed to minimize any inherent spatial non-uniformity of the MRI scanner. Experiments have been undertaken to develop a simple, validated, quality assurance technique, for use by radiographers in checking the spatial uniformity of the scanner before each clinical procedure. RESULTS AND CONCLUSIONS: The initial studies have generated patient images which give reliable diffuse and local CJD lesion visualization, combined with a sphere of uncertainty for point location and biopsy, employing the CRW surgical frame, of 1.8 mm. This development has applications in patients with new strains of CJD.

POSTER 0505

Assessment of accuracy of MRI localization in stereotactic surgery: a practical solution

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INTRODUCTION: MRI is increasingly used in stereotactic surgery, but is vulnerable to geometric distortion. The proximity of sensitive structures to biopsy sites demands highly accurate stereotactic localization. Regular quality control (QC) testing is required to ensure confidence in the accuracy of stereotaxy, but our past comprehensive QC methods required the availability of a full stereotactic surgical set and proved prohibitively time-consuming. To overcome these difficulties we designed a phantom to test the 3D accuracy of stereotactic coordinates with minimal data acquisition and analysis time. METHODS: The phantom comprises a Perspex cube of side 150 mm filled with copper sulphate solution. Attached to opposite corners of the cube and running diagonally through its centre are nylon wires onto which targets for stereotaxy (Perspex spheres of diameter 5 mm) are fixed. The phantom is secured within the stereotactic head frame and the relevant fiducial system attached. Stereotactic localization coordinates, acquired using CT (generally accepted as having an accuracy of ± 1.0 mm), are compared with those calculated from stereotactic localization MRI sequences. RESULTS: See table below. DISCUSSION: Only two out of 72 coordinates differed by more than 2 mm, compared with an estimated measurement accuracy of 1 mm. We feel our method may be used as a supplement to previous comprehensive testing and will make regular effective stereotactic QC a practicable possibility.

POSTER 0506

MRI measurement of relative cerebral blood volume in temporal lobe epilepsy

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PURPOSE: We used MRI relative cerebral blood volume (rCBV) maps to study regional haemodynamic changes in nine interictal temporal lobe epilepsy (TLE) patients and one ictal epilepsy patient for the detection of epilepsy foci. A precise localization of the epileptogenic zone is crucial for planning surgical treatment. MATERIALS AND METHODS: 10 patients with TLE were examined in a 1.5 T scanner with semicoronal T_1 weighted and PD/T_2 weighted images. For dynamic imaging we used a T_2 weighted FLASH-sequence with Gd-contrast medium (0.2 mmol kg^{-1} BW) injection (5 ml s^{-1}). Image processing of dynamic raw data was performed on a pixel-by-pixel basis. In eight patients, PET with 18-fluorodeoxyglucose were performed. rCBV maps and T_1, T_2, PD MRI images were analysed and compared with PET results. Regions of interest (ROI) were outlined and regional rCBV were measured. RESULTS: In seven of the nine interictal cases, lower rCBV of the left hippocampus was observed by MRI; all were confirmed by PET. Statistically significant ($p=0.01$, t-test) different ROI ratios (1.96/2.49 = left/right hippocampus to white matter) of rCBV were found. Left hippocampal atrophy was found in 6/7 cases on T_2, PD weighted images, with lower rCBV. In two TLE patients, lower rCBV areas were observed in right hippocampus. In the ictal case, the hyperintensity lesions (T_2 weighted) in the right frontal and parietal lobe with increased rCBV correlated to PET scan showing hypermetabolism in these regions. CONCLUSION: The results indicate that regional reduction of blood volume in temporal lobe epilepsy can be evaluated by contrast-enhanced MRI. In the patient studied during seizures, both PET and rCBV-MRI showed elevation of metabolic parameters. MRI based regional rCBV maps have the potential to facilitate selection of surgical candidates in epilepsy patients.

POSTER 0507

Diffusion-weighted MRI of cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy

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PURPOSE: To describe the MRI features in patients with cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) using conventional MRI and diffusion weighted sequence. MATERIALS AND METHODS: We reviewed 42 MRI examinations with T_1, T_2 weighted (TR/TE = 600;2500/15;90 ms) and diffusion-weighted gradient echo (PSIF) sequence (TR/TE = 23/2,3,5 ms; b-values 165, 288, 598 s mm^{-2}). The patients were 32–64 years old and had a positive family history of CADASIL. RESULTS: Two young patients (aged 32 and 34 years) with family history and headache had normal MRI images. 40 of the 42 patients had lesions as multiple small deep infarcts scattered in subcortical parietal (85%), frontal, occipital and temporal white matter and basal ganglia (25%), external capsule (55%), internal capsule, thalamus, brainstem and cerebellum (15%). More or less extensive and relative symmetric leucodystrophy was observed in 34 patients. Leucodystrophy of external capsule was identified in 16 patients. All lesions were readily identifiable by diffusion weighted MRI, whereas T_2 weighted imaging was less sensitive, especially in characterization of lesion size (68%) and number (93%). Atrophy was only found in two older patients (aged 64 and 60 years). No lesions were enhanced on enhanced T_1 weighted images. CONCLUSION: The MRI features of CADASIL are characteristic and well-observed with diffusion weighted imaging. There are multiple lacunar infarcts and leucodystrophy without contrast enhancement.

POSTER 0505 RESULTS: Difference between MRI and CT stereotactic coordinates (mm)

	Axial T_2 FSE	Axial PD FSE	Coronal T_1 spin echo	Axial inversion prepared spoiled grass	Coronal fast inversion recovery
Mean	0.68	0.82	0.98	0.91	0.9
Maximum	1.5	1.5	2.4	1.5	2.4

POSTER 0508

In vivo measurements of T_1 and T_2 to aid optimization of paediatric MRI brain imaging

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MRI protocols for the brain are well-optimized for adults. However, this is not the case in children, where the brain is still maturing. Loss of water content and myelination of the white and, to a lesser extent, the grey matter lead to a shortening of the T_1 and T_2 relaxation times of these tissues. The most rapid changes occur during the first 6 months following birth and contrast between grey and white matter changes significantly during this period. It is of clinical importance to be able to distinguish between myelinated and non-myelinated white matter to aid the diagnosis of diseases leading to hypomyelination and dysmyelination. It has been reported that inversion recovery sequences demonstrate the degree of myelination to a better extent than normal T_1 and T_2 weighted images. However, there is little data relating to the optimization of such sequences, especially in children. We have investigated the influence of inversion time on image contrast and, in particular, the ability to visualize the myelination tracks. Patient ages ranged from 10 days to 8 months and initial results show that longer inversion times may provide better visualization of the myelination process in very young infants. We have also performed measurements *in vivo* of the T_1 and T_2 relaxation times of grey and white matter, at different stages in brain development, using a MIX (inversion recovery and spin echo) sequence, which may be useful in the optimization of other routine pulse sequences used for infants.

POSTER 0509

A simple technique for dynamic perfusion scanning of cerebral tumours

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PURPOSE: Dynamic perfusion scanning (DPS) involves post-processing, which may not be widely available in clinical centres. We assessed a simple technique for DPS of cerebral tumours which can be performed by a radiologist supervising a clinical MRI session. MATERIALS AND METHODS: A 1.5 T Siemens Magnetom Vision scanner was used. 10 patients receiving iv gadolinium-DTPA for assessment of cerebral tumours were studied. Unenhanced T_2 weighted turbo spin echo images were used to detect areas of abnormal signal and select a suitable slice for DPS, which was performed using a 10 mm thick T_2 weighted slice at this level. A turbo-FLASH sequence (TE 80 ms, TR 8.5 ms, flip angle 10°) was used to obtain 80 images at 1.3 s intervals. 15 ml 0.5 mmol/mlk gadolinium-DTPA was given as a rapid bolus through a 20 G needle into an antecubital vein, starting at the tenth image acquisition. A post-contrast spin echo T_1 weighted sequence was then acquired to assess parenchymal enhancement. Inspection of this last sequence revealed suitable areas of enhancement for region of interest (ROI) analysis of the DPS images. The ROI signal was plotted on a graph as a function of time. RESULTS: Analysis of ROIs required approximately 20 min per patient. In eight patients the technique was successful, yielding neat graphical demonstration of the reduction in T_2^* signal of the lesion during dynamic enhancement. In two patients the technique was unsuccessful, due to selection of inappropriate (without significant enhancing tissue) slices for DPS. CONCLUSION: This technique is a very simple and relatively quick method of examining dynamic perfusion of cerebral tumours. We intend to use this method to compare various benign and malignant tumour types.

Chest

POSTER 0601

Withdrawn

POSTER 0602

CT of tracheal tumours

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Tracheal tumours are rare, comprising <1% of bronchial carcinomas. There are few published reports of the CT appearances of these tumours. We present the findings of a retrospective review of the CT appearances of tracheal tumours which have presented in the last 4 years to the regional thoracic unit at our hospital. 10 patients (seven male, three female; age range 47–82 years, mean age 63) were included in the study. All patients underwent a dynamic scan of the thorax using 100 ml iv Niopam (Philips Tomoscan). The majority 8/10, had mid- to lower-third involvement. Features noted included endoluminal tracheal mass (two cases), tracheal wall thickening (six cases), tracheal narrowing (six cases), pre-tracheal soft tissue masses (two cases) and sub-carinal soft tissue (one case). Invasion into adjacent lung structures was seen in three cases. No oesophageal invasion was noted in any of the cases. Examples of the CT abnormalities will be demonstrated and radiological features reviewed.

POSTER 0603

Functional differences in pulmonary fibrosis chronic sarcoidosis _vs_ cryptogenic fibrosing alveolitis

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PURPOSE: To evaluate whether there are differences in functional behaviour between a given extent of fibrosis identified on high resolution CT (HRCT) in patients with chronic sarcoidosis, *vs* patients with cryptogenic fibrosing alveolitis (CFA). SUBJECTS AND METHODS: The HRCT images of 22 patients with CFA (17 male, five female; mean age 59.5 years) and 16 patients with chronic sarcoid (six male, 10 female; mean age 50.5 years) were independently evaluated by two observers. At five levels the extent of several patterns were scored to the nearest 5%: reticular pattern, including its bronchocentricity and coarseness; nodules (1–20 mm); conglomerate fibrotic masses; ground glass opacification; and areas of decreased attenuation. The individual patterns were correlated with spirometric and plethysmographic lung-function tests. The statistical evaluation included univariate and multivariate analyses. RESULTS: In both groups the extent of a reticular pattern was not significantly different ($38.9 \pm 16.7\%$ in CFA *vs* $29.9 \pm 16.3\%$ in sarcoid). Taking both conditions together, there were significant negative correlations between the extent of fibrosis and indices of restriction [total lung capacity (TLC): $r = -0.56$, $p = <0.0005$] and obstruction [right ventricle (RV): $r = -0.33$, $p = <0.04$; forced vital capacity (FVC): $r = -0.53$, $p = <0.001$]. Nodules and areas of decreased attenuation, seen in sarcoidosis, showed positive correlations with indices of obstruction (RV: $r = 0.4$, $p = 0.01$ for nodules, $r = 0.44$, $p = 0.005$ for areas of decreased attenuation). On multivariate analysis, an obstructive component was significantly higher in sarcoid than in CFA (RV: 21.7% greater, $p < 0.0005$, RV/TLC: 12.7% greater, $p < 0.001$). CONCLUSION: For a given extent of a reticular pattern on HRCT, which is known to reflect interstitial fibrosis, there is significantly more air-trapping, as measured by plethysmographic lung volumes, in sarcoidosis than in cryptogenic fibrosing alveolitis.

POSTER 0604

Determination of positional effect on pulmonary perfusion gradient using electron beam CT

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PURPOSE: Prone positioning improves oxygenation in up to 70% of patients with the acute respiratory distress syndrome (ARDS). The mechanism is believed to result from improved ventilation/perfusion relationships. The effects of prone positioning on the distribution of regional pulmonary perfusion remains unclear. Electron-beam CT which allows evaluation of pulmonary perfusion within specified regions of interest (ROI), was used to study the effects of position on the distribution of pulmonary perfusion in six healthy, male individuals. METHODS: Individuals were established on positive pressure ventilation via a mouthpiece. Repeated sections were obtained, at a single level through the lower lobes, during the injection of iv contrast, with respiration held in inspiration. Subjects were studied supine, prone and again in the supine position. ROI were placed in designated positions on the images acquired and perfusion calculated relative to the mean perfusion of the whole slice, using accepted equations for this technique. RESULTS: A gravitational gradient in pulmonary perfusion existed in both supine and prone positions. Perfusion increased from ventral to dorsal regions (relative perfusion—supine(%)/*prone*(%): 63.3/*79.3*; 95.6/*109.5*; 122.7/*132.0*; 132.0/*130.1*; 121.6/*119.0*), maximal values occurring at 50–70% of the ventral–dorsal distance. Analysis (two-way ANOVA), revealed no significant difference between the distribution of perfusion seen in either supine or prone position. CONCLUSION: This technique has the potential to assess the effects of prone positioning on the distribution of pulmonary perfusion in patients with ARDS.

POSTER 0605

Clinical utility of thoracic MRI: a regional centre's experience

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There is still controversy over the clinical role of thoracic MRI. We have reviewed our experience in a regional thoracic unit over a 2.5 year period, looking at clinical indications, imaging parameters, scan findings and clinical value. 47 patients (29 female, 18 male) were scanned (age range 14–89 years, mean 55 years). The clinical indications for imaging included assessment of site and extent of tumour spread, or recurrence, within the thorax or axillae; the further investigation of intra-thoracic masses; assessment of chest wall deformity; and the further investigation of bilateral axillary vein thrombosis, bilateral vocal cord palsy and aortic stenosis. The imaging technique most commonly employed used axial T_1 and T_2 and coronal T_1 images, with other imaging planes and STIR sequences used where necessary. The findings were diverse and included: eight patients with carcinoma of the bronchus, two with chest wall recurrence, one with mediastinal invasion and one with pleural cavity with mass; one cardiac mass; one benign pleural fibroma; one post-operative mesothelioma; two descending thoracic aortic aneurysms; two recurrences of breast carcinoma; one rib and para-vertebral neurofibromata and one giant cell arteritis of the right pulmonary artery, masquerading as a pulmonary artery mass. In all but one of these cases the imaging was of clinical value, with a definitive diagnosis being made in 34 patients. These findings and a selection of the images will be presented.

Education

POSTER 0701

An analysis of a computer-based guided discovery learning environment for skeletal scintigraphy

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BACKGROUND: Three methods of multimedia learning have previously been assessed for effectiveness. Using three groups of volunteers, all three methods demonstrated a significant pre- to post-session knowledge gain ($p=0.001$). However, it was established that computer-assisted learning (CAL), based on the guided discovery method, was superior to the two other conditions (traditional lecture and electronic book CAL). PURPOSE: To identify which guided-discovery CAL design principles contribute to effective learning. METHOD: 45 volunteers experienced the guided discovery and electronic book CAL. Various qualitative measures were taken, including observation, questionnaire, focus group discussion and interview. DISCUSSION: Volunteers indicated the guided discovery environment was suited to the acquisition of new knowledge. By contrast, the electronic book supporting free hypertext was considered suitable for information searching and not necessarily conducive to effective learning. Volunteers identified several guided-discovery design principles, which contributed to effective learning. Learning in context with real examples assisted the integration of diverse subject material. Learners were able to discover underlying principles and knowledge for themselves, rather than be told the information in a didactic fashion. The learning experience engaged volunteers in active, rather than passive, learning. Information was presented in a fashion which enabled understanding of the complex domain to occur progressively, at a speed at which the learner wished to progress. These findings may have significant value for academic and clinical skill-building in radiography, where students are expected to integrate theory and practice from complex domains. The use of computer-based virtual environments, based on guided discovery, may have a value in subject integration and the application of theory in simulated practice.

POSTER 0702

A study of the expectations of managers regarding newly qualified radiographers

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PURPOSE: To investigate whether there was a gap between radiography training provision and employers' requirements and to ascertain whether there was a difference in requirements between diagnostic and therapy departments. METHOD: A list of attributes which graduates may have was devised from nursing literature and a panel of radiography experts. These attributes were then sorted into managerial, professional, patient care, interpersonal and discipline specific categories. A modified, two-round, Delphi technique was then used to work towards a managers' consensus. Attributes that had a significant difference (Mann–Witney U significance level set at $p<0.05$) between therapy and diagnostic consensus were moved from their respective group into the discipline specific group. RESULTS/DISCUSSION: The most desirable characteristics expected in each of the categories were: ability to cope with working under pressure (management), adherence to local rules and a commitment to working within the health and safety guidelines (professional), awareness of own limitations and working as part of a team (interpersonal skills), ensuring patient confidentiality (patient care). The average score across all categories was similar, although the number of attributes in each group varied considerably. Accountability within higher education dictates implementation of a comprehensive evaluation plan. If health educators want to ensure that they provide what the clinical departments both expect and desire in newly-qualified radiographers, student assessments should incorporate evaluation within the areas specified.

POSTER 0703

Pattern recognition in trauma plain film radiography

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Following evaluation of the University of Bradford Postgraduate Certificate Course in Radiographic Image Interpretation and in the light of continuing professional development, research funding was obtained to ascertain whether there was a market for a short, affordable, intensive course of study in plain film pattern recognition of trauma images, of the axial and appendicular skeleton, to enhance the Red Dot system of work in Accident and Emergency Departments. The market was tested using a short questionnaire sent to the Imaging Services Manager in over 270 Imaging Departments which provide an accident and emergency service, across all the Health Regions in the UK (excluding Northern Ireland). The response has been very encouraging, with a reply rate to date of 70% and a large proportion of those responses stating that such a course would be very valuable for their staff. The study will aim to ascertain the viability of a workshop-based course, delivered principally by reporting radiographers and run over 2 days. The effectiveness of the course will be assessed by evaluating radiographers on the course, along with a control group, immediately prior to the course and at 1 month after the course. The outcomes will be analysed to see if there has been any significant improvement in the radiographers' ability to differentiate accurately between normal and abnormal plain films.

POSTER 0704

Introduction of supervisory skills to radiographers to enable facilitation of learning in the workplace

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Students undertaking the BSc(Hons) in diagnostic or therapeutic radiography spend 50% of the course on clinical placement. Clinical tutors facilitate learning in the departments for only a fraction of this time and clinical staff are depended upon to supervise around 1500 h per student over 3 years. This massive task relies on acquisition of adequate supervisory skills and some understanding of the learning process. In 1993, the Division of Radiography at Queen Margaret College initiated study days to enable radiographers to gain basic knowledge in this area. Honey and Mumford's (1992) "Preferred Learning Styles" questionnaire permits self-analysis and participants are then able to liken observed student behaviour to reflective, theoretical, pragmatic and active learning. Role-play is used to reinforce these styles. The norms for radiographers have been calculated and results are pending. Semi-structured questionnaires were distributed to all previous attendees and results are pending. These study days will continue and adapt to nurture the skills and knowledge necessary for effective facilitation of learning in the workplace.

POSTER 0705

The MR appearances of the anterior interosseus nerve syndrome

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PURPOSE: The anterior interosseus nerve syndrome leads to weakness or paralysis of muscles innervated by this nerve. Weakness predominating in one muscle may lead to an erroneous diagnosis of tendon rupture. Electromyographic studies have been shown to help in establishing a correct diagnosis. This study aims to identify the MRI features of the anterior interosseus nerve syndrome and indicate its use as a non-invasive diagnostic tool for diagnosis of this syndrome. METHODS: Three patients with symptoms attributable to the anterior interosseus nerve syndrome underwent forearm MRI in our unit. In each case axial T_1 weighted and fast STIR images were obtained. RESULTS: All patients showed diffusely increased signal from some or all muscle groups innervated by the anterior interosseus nerve on STIR images. Atrophy in the muscles innervated by the anterior interosseus nerve was shown in one of the patients. None of the patients showed any evidence of tendon tear or rupture. CONCLUSION: MRI has a useful role to play in diagnosing the anterior interosseus nerve syndrome. It has the advantage over electromyographic studies in being non-invasive and less painful to the patient, technically easier to perform and less operator dependent.

POSTER 0706

The role of visual search in the interpretation of diagnostic images

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The interpretation of diagnostic images is a complex task that relies on perceptual and cognitive processes. Understanding the underlying processes which affects diagnostic efficacy is essential, but investigating these processes is troublesome, as expert film readers often find it difficult to verbalize what has become an intrinsic skill. One experimental method that can overcome this problem involves recording the visual search patterns of film readers, as they interpret diagnostic images, by monitoring their eye movements. This paper briefly introduces the techniques behind eye movement recording. The research literature that has utilized these methods is then examined. The results of these studies are compared and insights into the nature of the processes involved in diagnostic image interpretation are discussed. This extensive review of studies that have examined the visual search behaviour of film readers demonstrates that the use of eye-movement recording techniques can give valuable insights into the processes involved in radiographic image interpretation. This experimental technique is unique, in that it actually records what expert readers do, rather than what an they "think" that they do, therefore the results of such studies are useful in defining the skill. The areas of diagnostic image interpretation that are currently being investigated, or may benefit, from investigation using eye-movement recording are detailed.

POSTER 0707

Intraobserver variability and accuracy when re-reporting plain radiographs after 24 h

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PURPOSE: Supplementary reports are occasionally necessary when retrospective observations are made. This study assesses change in accuracy and the degree of intraobserver variability when radiographs are reviewed after a 24 h period. METHOD: Five consultant radiologists reported 50 plain radiographs on two separate occasions 24 h apart. Radiographs included chest, abdominal and extremity views. The diagnoses had been established from histology, other laboratory tests or follow up. 32 radiographs showed abnormality, 18 were normal. Clinical information was available. The radiologists gave the diagnosis or most appropriate differential. They indicated how certain they were of their interpretation for each radiograph stating one of the following: normal, probably normal, possibly normal, probably abnormal, abnormal. The diagnoses were assessed as positive/negative, based on a cut-off point in the scale between possibly normal and probably abnormal. ROC curves were produced to show accuracy for the group on the two occasions and κ statistics were used to calculate intraobserver variability. RESULTS: Accuracy showed a range of 78–90% on the first and 80–92% on the second viewing. This difference was not statistically significant at 5% level, the areas under the ROC curves were 0.88 and 0.92, respectively. κ values were 0.33, 0.5, 0.7, 0.73 and 0.88. CONCLUSION: The lower κ values for some radiologists indicate that these made a similar number of errors on the two occasions, but on different radiographs. Overall, these results suggest that a significant increase in accuracy is not achieved if radiographs are re-reported at 24 h.

POSTER 0708

Systematic literature review of endoscopic US and gastric cancer

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PURPOSE: To determine preoperative staging accuracy of endoscopic US (EUS) in gastric cancer by reviewing the literature. METHODS: Our methodology for systematic reviews in medical imaging is based upon published work with adaptations, particularly for assessment of study validity. Validity assessment involves completion of a checklist posing questions designed to identify the presence of biases in study conduct, data interpretation and patient selection, which could affect reported results. Firstly, studies were identified using electronic databases, conference proceedings and relevant non-indexed journals. Each was assessed against inclusion criteria: relevant original study; "gold standard" of pathology; >10 subjects; and able to express results in 1987 TNM system. Studies included were assessed using the validity checklist and the TNM results were noted. Logistic regression was applied to identify relationships between presence of bias and the TNM results. As a summary indicator of EUS staging performance, the sensitivity and specificity for discriminating T1 and T2 from T3 and T4 were found. RESULTS: 76 candidate English language studies were identified. Nine satisfied the inclusion criteria, but all suffered from potentially biasing study design, or reporting deficiencies (discussed separately). The range of sensitivity/specificity (eight studies) was 67.9–96.7%/87.5–100%. For the single study which reported blinding observers to avoid diagnostic and test review, biases were 91.7%/97.4%. CONCLUSIONS: Although there is a significant published literature addressing the staging performance of EUS, deficiencies in reporting and study design mean that definitive results are currently not available.

Head & Neck

POSTER 0801

Plain radiography in imaging of the paranasal sinuses: one or three views?

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PURPOSE: International guidelines on radiographic technique in paranasal sinus imaging vary because there is only limited data on the acceptability of a single occipito-mental (OM) view, as opposed

to the traditional three-view series. This study was designed to investigate whether a single OM view can achieve the diagnostic accuracy of the three-view series, with the advantages of time, cost and radiation savings. MATERIALS/METHODS: Our department uses the three-view technique. A retrospective study of the radiographs of 100 consecutive adult patients was performed. Two radiologists (one with single view technique experience) each reported a single OM view and later the three-view series. Radiographic technique was assessed. Statistical analysis used the κ test of reliability. RESULTS: κ values showed acceptable agreement for both radiologists ($\kappa = 0.59$ and 0.78) in overall diagnosis when comparing single and three-view reports. Individual sinus analysis showed acceptable agreement for frontal ($\kappa > 0.4$) and maxillary findings ($\kappa > 0.8$). The viewer familiar with the single OM technique also showed agreement for ethmoid findings ($\kappa > 0.4$). These results were despite poor radiographic technique, which confounded sphenoid findings. CONCLUSION: The results of this study suggest a single OM view can achieve diagnostic accuracy similar to the three-view series and could satisfactorily replace it. However, attention to radiographic technique and education in the radiological technique of interpretation of the sinuses on the OM view is essential. Further investigation is needed before consensus on the place of the single OM view *vs* the traditional three-view technique can be achieved.

POSTER 0802
Withdrawn

POSTER 0803
Withdrawn

POSTER 0804
Withdrawn

POSTER 0805
High resolution MRI of the larynx
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PURPOSE: To improve our current ability to accurately stage laryngeal carcinoma with MRI and allow a prospective comparison with spiral CT. METHOD: Images were acquired on a 1.5 T GE Signa system using a dual phased array coil. Four different sequences, each allowing 18 slices, were assessed in the axial plane on volunteers for image quality and patient tolerance. The sequences utilize a slice thickness of 3 mm, with a 0.3 mm interslice gap. A field of view of 12 cm and a 256×192 matrix gave an in-plane resolution of 0.47×0.63 mm. (a) T_1 weighted fast spin echo (FSE) TR = 460 ms TE = 13 ms 4:07 min. (b) PD weighted FSE TR = 2000 ms TE = 11 ms 3:23 min. (c) T_2 weighted FSE fat saturated TR = 2020 ms TE = 120 ms 5:16 min. (d) Fast STIR TI = 140 ms TR = 2160 ms TE = 14 ms 5:11 min. Where possible images were acquired over more than one acquisition per sequence, in order to limit the effects of possible motion to a small number of images. The application of narrow RF suppression bands along both anterolateral aspects of the neck reduced the amount of phase-ghosting that occurred at such air–tissue interfaces. CONCLUSION: The technique was found to be well-tolerated on both volunteers and two patients upon whom post-contrast images were also obtained with good diagnostic quality.

POSTER 0806
Clinical usefulness of bone scintigraphy in laryngeal cancer
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PURPOSE: To investigate the potential of bone scintigraphy in the control of laryngeal cancer by radiotherapy. METHOD AND MATERIALS: Patients with laryngeal cancer, who were managed with curative intent by radiotherapy in the Department of Radiology, Nagoya University Hospital from January 1995 to March 1997, were reviewed. Retrospective analyses of bone scintigraphy were performed on 37 patients with laryngeal cancer and 37 patients without head and neck cancer. Bone scintigraphs were separately reviewed by two radiologists without clinical information. RESULTS: Clinical stages of patients with laryngeal cancer were T1, 16, T2, 15, T3, three and T4, three cases. There were 14 patients who underwent the laryngectomy because of poor response to radiotherapy (ope-group). Six patients had a local recurrence of the tumour (rec-group). Tumours of the other 17 patients were well controlled (well-group). There were three patients with increased uptake in the larynx among the patients without head and neck cancer and 12 among the patients with laryngeal cancer ($p < 0.01$). There was no relation between clinical stage and increased uptake in the larynx. There were nine patients with increased uptake in the larynx in the ope-group, one in the rec-group and two in the well-group. Invasion to the laryngeal cartilage was verified in five cases out of nine of increased uptake in the ope-group (two by pathology and three by MRI). CONCLUSION: From these results increased uptake in the larynx suggests resistance to radiotherapy, the main reason for this may be invasion of the laryngeal cartilage.

Interventional Radiology

POSTER 0901
CT-assisted cervical peri-radicular corticosteroid injection for cervico-brachial pain: a safer approach
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Peri-radicular injection of corticosteroids and local anaesthetic agents, to control radicular pain, using fluoroscopic guidance, is a long-standing, established technique. With fluoroscopy, the exact position of the needle tip may be difficult to determine, even when multiplanar fluoroscopy, with c-arm image intensification, is available. An inadvertent puncture of the subarachnoid space or major vascular structures can occur, with significant complications. For these reasons, a CT-guided approach, which allows an assessment of the anatomy in each case, and an appropriately planned approach to the optimal injection site, whilst avoiding important vascular structures and subarachnoid space injection, has been developed. Details of this technique and the anatomical considerations will be discussed.

POSTER 0902
Withdrawn

POSTER 0903
Factors influencing US-guided puncture of the internal jugular vein
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PURPOSE: To examine success and complication rates for US-guided cannulation of the internal jugular vein (IJV) in comparison with blind techniques and observe the effect of variations in the anatomy of the vein. METHOD: Data was prospectively collected from 1115 cases of sonographically-guided cannulation of the IJV. In all cases the side of the puncture, whether the procedure was successful and any immediate complications were recorded. In 976 (87.5%) cases the number of passes required and whether a single or double wall puncture was effected was recorded. In 876 (78.6%) cases IJV diameter and depth were recorded, whilst its position relative to the carotid artery (CCA) was noted in 862 (77.3%) cases. The initial 250 punctures were performed mainly by staff interventional radiologists, whilst the majority of the later punctures were performed by residents and fellows. RESULTS: Cannulation was successful in 1114 (99.9%) cases. Complications of puncture of the IJV occurred in 17 (1.5%) cases. These were 16 (1.4%) cases of inadvertent arterial puncture and 1 (0.1%) pneumothorax. 86.2% of cannulations were achieved with one pass and 82.3% with a single wall puncture. Only 3.1% of punctures needed more than two passes. Success at first pass was significantly correlated with right-sided puncture and the diameter of the IJV. In 6.3% of cases the IJV lay medial to the CCA, making successful cannulation using the landmark technique unlikely. CONCLUSIONS: US-guided cannulation of the IJV is superior to blind techniques with increased success rate, higher incidence of first pass cannulation and lower incidence of complications.

POSTER 0904
US-guided jugular placement of central lines: proven patient, training and cost benefits
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PURPOSE: To investigate patient outcome and complications, training of junior radiologists and cost-benefits of providing a venous access service. METHODS: A retrospective review of 200 consecutive US-guided venous catheters, inserted by different grades of radiologist, via different venous access routes. We reviewed the time taken to perform the procedure, the early and late complication rates and the length of time the catheter remained *in situ*. A further comparative analysis was undertaken to assess the US-guided jugular technique, against the standard blind subclavian venous puncture technique. RESULTS: There was no significant difference ($p<0.05$) between the time taken by consultants and senior registrars to perform the procedure and that taken by junior registrars. The early and late complication rates were similar in both groups. The length of time the catheter remained *in situ* was also similar in both groups. The results of the comparative analysis, against the blind technique, clearly demonstrated significant time, complication rate and cost benefits. CONCLUSION: Using a US-guided jugular approach, junior radiologists can easily be trained to acquire a similar level of competence with comparative procedure times as more senior colleagues. Junior staff have similar complication rates as senior staff, which are significantly lower than those associated with the standard technique. There are cost-benefits associated with the described technique, both in terms of reduced room time required and reduced equipment costs.

POSTER 0905
Coronary angioplasty; correct sizing of a vessel using imaging balloons and X-ray picture-in-picture
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PURPOSE: A new development in the cardiac angiography suite has led to a greater accuracy in sizing vessels pre-angioplasty. Picture-in-picture (PIP, Siemens), in conjunction with an intravascular US (IVUS) computer, allows the production of simultaneous angiographic and IVUS parameters, prior to and during angioplasty. This is achieved using an imaging balloon which is a high pressure angioplasty balloon that allows both imaging and dilatation to be achieved with the same device. This method has been used in 10 patients. In three, coronary stents were also mounted on the imaging catheter and deployed in the vessel using IVUS guidance. IVUS has shown that angiography alone under-estimates the vessel diameter by up to 1 mm, resulting in under-dilatation. The imaging balloon not only allows the choice of balloon size to be optimized, but also allows an appreciation of the result of angioplasty and can be used in deciding when stent placement is required. We have shown that the imaging balloon is a versatile tool, optimizing therapeutic management in selected patients undergoing coronary angioplasty.

POSTER 0906
Evaluation of the Memotherm (Bard) transjugular intrahepatic portosystemic stent shunt
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PURPOSE: Evaluation of Memotherm TIPSS. Theoretical advantages include accurate positioning and adequate length, so only a single stent should be required. MATERIALS AND METHODS: 37 patients with recurrent variceal bleeding underwent TIPSS procedure using the Memotherm stent. A 12 mm × 8 cm stent was used in most cases. The stent was deployed to the right hepatic vein origin, to prevent subsequent hepatic vein stenosis. The stent was dilated progressively, using balloons 8–12 mm in diameter, until the pressure gradient was ⩽12 mmHg. Patients were followed-up using Doppler US before discharge and at 3, 6, 12, 18 and 24 months and annually thereafter. Reintervention was undertaken if there was clinical or US suspicion of TIPSS dysfunction. RESULTS: Technical success was 100%. Initial mean portal pressure gradient was 20.4 mmHg. Final mean portal pressure gradient was 8.3 mmHg. Two cases required a second stent. 30 day mortality was 7/37 (19%). Six further patients subsequently died and two were lost to follow-up. Seven cases (19%) required reintervention, including for hepatic vein stenosis in two, pseudo-intimal hyperplasia in four and stent fracture in one. Of these, four were redilated and three had further stents placed. There were no cases of TIPSS occlusion during the follow-up period of 1–36 months (mean 18 months). Primary assisted patency rate was therefore 100%. CONCLUSION: The Memotherm stent is associated with a high technical success rate and low rates of reocclusion and reintervention. A single stent is adequate in most cases.

POSTER 0907
Coil embolization in renal haemorrhage following percutaneous biopsy or nephrolithotomy: experience in nine cases
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AIMS: Retrospective analysis to assess clinical outcome in nine patients who underwent selective angiography and subsequent coil embolization to treat renal haemorrhage following percutaneous renal intervention. METHOD: The case notes were reviewed of nine patients, mean age 58.8 years (range 27–74) who suffered significant renal haemorrhage following percutaneous biopsy (six), or access for percutaneous nephrolithotomy (three), between 1995 and 1997. RESULTS: Eight patients (percutaneous biopsy six; PCNL two) were identified to have a significant arterio-venous (A–V) fistula on angiography. In this group, eight patients (100%) had immediate technical success and subsequent clinical improvement with no complications. In a single patient (PCNL) a small A–V fistula was coil embolized, but the patient had continued, significant haemorrhage. Subsequent nephrectomy revealed rupture of a large lower pole vein. CONCLUSION: Renal angiography and subsequent embolization is an effective and safe method of managing iatrogenic renal haemorrhage.

POSTER 0908
Embolization: the first-line treatment for post-partum haemorrhage when medical management fails
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The purpose of this review was three-fold. Firstly, to review our experience from the last 3 years (since the installation of PACS) and determine the outcome of embolization. Secondly, to compare our data with other literature and thirdly, to bring to the attention of radiologists how this relatively straightforward procedure can avoid major surgery and prevent death. MATERIALS AND METHODS: Four patients with post-partum haemorrhage (PPH) were referred, during a 3 year period, for angiographic localization

and embolization (age 24–42 years) of the site of bleeding. Each patient required blood transfusion (range 6–33 units). Two patients were post-LSCS (one for twins) the others were primigravidae post-spontaneous-vaginal delivery. Free flush aortography, selective iliac and super-selective iliac angiography were performed using a 5 chFr pigtail, 5 chF glidecath cobra and, in two patients, a Tracker co-axial catheter system. All bleeding sites were easily identified and embolized using polyvinyl alcohol particles and gelatin sponge. RESULTS: The results were dramatic in all cases. Bleeding was instantaneously arrested. No further bleeding occurred in any of the four patients. One patient developed a pyometria which was thought to be due to the prolonged exteriorization of the uterus during manual compression after a LSCS. CONCLUSION: All four of our patients developed life-threatening PPH, which was arrested immediately following selective and super-selective embolization of the iliac artery branches. Arterial embolization for PPH has not been well-documented in the UK literature, however, our outcomes are similar to the few reported series. The procedure is relatively straightforward and can be performed in most radiology departments with angiographic facilities.

POSTER 0909

Success rate and complications following endoluminal stent-graft insertion for abdominal aortic aneurysm

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PURPOSE: Open surgical repair of abdominal aortic aneurysm (AAA) is associated with a high morbidity and mortality. The purpose of this study was to determine the success rate and complications of endoluminal stent-graft insertion. METHODS: 28 patients underwent endoluminal stent-graft insertion for AAA. The follow-up protocol required spiral CT angiography at 3–5 days, 6 weeks and 6, 12 and 24 months after insertion, or when complications were suspected. The initial success rate (successful deployment of the device and complete exclusion of the aneurysm at intraoperative angiography), frequency and outcome of complications were evaluated. Mean follow-up was 10.7 months (range 1–24 months). RESULTS: In 15 patients (54%), 13 tube grafts (11 aorto–iliac, two aorto–aortic) and two bifurcated grafts were inserted successfully. Post-surgical complications occurred in six (40%) of these patients: leaks (two patients at 3 days), graft infection (one patient at 4 months), saddle embolus (one patient at 4 months), graft loosening (one patient at 4 months), twisting of the graft (one patient at 24 h). Secondary intervention resolved four of these. Endovascular stenting was unsuccessful in 13 out of 28 cases (46%), necessitating conversion to open repair. The causes were: stent leakage (four), bursting of balloons (two), iliac tortuosity (two), stent slippage (two), neck rupture (one), too wide a neck (one), wrong stent size (one). CONCLUSION: Our preliminary results show that endovascular stent insertion is successful in approximately 50% of patients. However, complications following this procedure are common. In many cases these can be treated successfully by secondary radiological intervention.

POSTER 0910

Endovascular treatment of anastomotic iliac artery aneurysms complicating bifurcated aorto–iliac grafting

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Anastomotic pseudoaneurysm formation is the commonest complication of aortic grafting for treatment of abdominal aortic aneurysm, particularly occurring at the distal anastomosis site of bifurcated aorto–iliac prostheses. Treatment of such iliac artery aneurysms is usually surgical, but successful percutaneous embolization has recently been reported. We present three cases of anastomotic iliac artery aneurysm complicating bifurcated aorto–iliac grafting; these illustrate the options available for endovascular repair. In one patient, a 5 × 11 cm aneurysm of the native common iliac artery was too large for covered stent occlusion, but successful embolization of the aneurysm neck was achieved with tungsten coils. In the second patient, coil embolization of a large external iliac artery (EIA) aneurysm was precluded by the wide neck and high flow within the aneurysm; successful occlusion was achieved by percutaneous placement of a covered stent across the aneurysm origin, between the iliac limb of the graft and the native EIA. In the third patient a covered stent was placed in a similar manner to occlude an internal iliac artery aneurysm arising at the anastomosis site. The only complication was post-procedure buttock claudication in the patient treated by embolization. Continued occlusion of all three aneurysms was confirmed by follow-up angiography or colour flow Doppler US. In conclusion, anastomotic iliac aneurysms complicating bifurcated aorto–iliac grafting can be successfully occluded by percutaneous embolization with tungsten coils or placement of a covered stent.

POSTER 0911

The role of rotational angiography in iliac artery assessment

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PURPOSE: Rotational angiography is a new development in the assessment of the vascular tree. Previous work has predominantly focused on coronary and cerebral artery assessment by comparison with standard angiographic techniques. We prospectively evaluated the value of rotational angiography as a diagnostic tool in the assessment of the iliac arteries. METHOD: Patients attending for diagnostic angiography over a 7 month period were studied with a GE Advantx LCA digital system. All rotational angiograms were identified as diagnostic or non-diagnostic and, where possible, the angles of the bifurcations of the common iliac arteries (CIA) and common femoral arteries (CFA) determined. The injection-to-image delay, arc angles of spins and radiation doses were recorded. RESULTS: 101 patients were studied. The spin sequence was diagnostic in 94 (93%) patients. An arc of 120° (60° LAO to 60° RAO) was used in 79%. The mean angles of the bifurcations on the right and left sides was evaluated. The mean injection to image delay was 3.7 s (range 0.5–6 s). The average radiation dose for the spin sequence was 715.6 cGy cm^{-2}. CONCLUSIONS: The rotational study of iliac arteries is diagnostic in the majority of patients studied, such that this is now a routine sequence and has obviated the need for static oblique studies, thereby reducing contrast volumes and the radiation dose.

POSTER 0912

Assessment and monitoring of lower limb arterial stents using triplex ultrasound

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This project determined the patency of lower limb arterial stents following implantation and over a 2 year period at 6 monthly intervals. US was used to provide a non-invasive method of assessing and monitoring patency. The US examination involved assessment of appearance of the stent and neighbouring arterial lumen. In addition, spectral flow characteristics were measured to determine if indices could be used as predictors of stent occlusion. The cohort consisted of 67 patients, of whom approximately 60% were subjected to full follow-up. Within this group there were approximately 5% acute occlusions. Two occlusions did not display overt signs or symptoms. The velocity indices gave no clear prediction of stent occlusion, although subjective evaluation of intimal hyperplasia was noted in the failed stents. It was concluded that US imaging provided an accurate indication of patency, but velocity indices were of limited value in predicting subsequent occlusion.

POSTER 0913

Thrombolysis for acute lower limb ischaemia in a district general hospital—is it feasible?

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PURPOSE: To assess the feasibility and clinical effectiveness of undertaking thrombolysis in patients presenting with acute lower limb ischaemia in a busy district general hospital. MATERIALS AND METHOD: 28 patients presenting with 32 acutely ischaemic legs over a 3 year period were treated with a low dose intraarterial infusion (0.5 mg h^{-1}) of recombinant tissue plasminogen activator (rTPA), along with heparin at 500 iu h^{-1}. All patients were managed on a general surgical/vascular ward rather than a high dependency unit or intensive care unit. Check arteriograms were undertaken in the X-ray department 4–6 hourly and any underlying stenosis dilated with balloon angioplasty. Full blood count, clotting studies and fibrinogen levels were monitored 6 hourly. RESULTS: Successful lysis occurred in 27 legs (84%) after a mean infusion time of 24 h. Angioplasty was required in 16 legs (50%). All five patients in whom lysis was unsuccessful required above knee amputation. No major complication was recorded directly attributable to thrombolysis. CONCLUSION: Thrombolysis for acute lower limb ischaemia can be effectively and safely undertaken in a busy district

general hospital. A low dose regimen is favoured as this does not require long periods in a screening room, or intensive nursing. Monitoring angiograms and angioplasty can be "fitted-in" around fully booked lists, allowing continued efficient use of radiology resources. Close co-operation between radiological, surgical and nursing staff allowed the patients to be safely managed on a general surgical–vascular ward.

POSTER 0914

Therapeutic interventional radiology in the treatment of peripheral vascular disease in the very elderly population

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PURPOSE: To evaluate the indications for, and outcome of, peripheral angioplasty and surgery in a group of patients aged ⩾90. METHOD: All the patients ⩾90 undergoing peripheral angioplasty or surgery over a period of 1 year were reviewed. The indications for the procedures were assessed and both quantitatively and qualitatively followed up. Both ankle brachial pressure index (ABPI) measurements and Doppler velocities were used to give quantitative data. All surgical procedures and outcomes on this age group were also assessed. RESULTS: There were two male and 11 female patients whose average age was 92.5 years. Seven patients (53%) were referred as emergency admissions. None of these had been previously investigated. All 13 patients had Stage IV vascular disease, 11 with non-healing ulcers and rest pain, two with acute or chronic ischaemia. 15 procedures were performed, including four recanilizations of occlusions of both the SFA and popliteal arteries. In seven patients there was marked improvement in symptoms, with concurrent improvement of ABPI at 6 month follow-up. There were two peri-procedural deaths, both from sudden cardiac arrest at 24 48 h. During the same period three patients had femoral–popliteal by-passes performed, two died in the post-operative period, both from left ventricular failure. CONCLUSION: Angioplasty provides a safe effective method of managing peripheral vascular disease in the very elderly, high-risk population.

Management

POSTER 1001

Data entry and retrieval from radiology information systems

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PURPOSE: To determine and present a structured data entry on a radiology information system (RIS), which results in an effective and controlled data retrieval system. SUBJECT AND METHODS: Our study was based on a software relational database management system (RDBMS) and a commercial programing environment, Microsoft Visual Basic. Existing coding systems, such as ICD-9, ICD-0 were used in combination with a new system we developed to code radiological findings. We initially designed the interface of the program with the user physician and finally developed the search engines. RESULTS: The prototype version of our program is used throughout a broad spectrum of imaging techniques (MRA, MRI, CT, DSA, US) to give semi-automatic code free-text radiological reports. The program also permits the connection of a patient ID with free-text radiological reports, basic clinical features and medical history. CONCLUSION: The most important features of a radiology information system is its structured data entry, controlled data retrieval and ability to allow the user physician to create and execute his own queries based on the appropriate search engines.

POSTER 1002

MRI of claustrophobic patients who refuse a conventional scan

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PURPOSE: To evaluate how many claustrophobic patients previously refusing a conventional MRI scan were able to tolerate an open scanner. Patients' reasons for this were investigated. Toleration of the investigation by patients and part of the body being scanned were also assessed. MATERIALS AND METHOD: 30 patients unable to tolerate MRI investigations due to claustrophobia in a conventional, tunnel-type scanner were selected. No other selection criteria, such as age or clinical diagnosis, was used. These patients were offered an investigation in an open scanner. The same part of the body was to be imaged using either scanner. Patients were assessed for ability to tolerate the investigation using the open scanner. The number refusing the open scanner was recorded. If diagnostic quality scans (assessed by radiologists) were produced, this was deemed a successful investigation. RESULTS: 95% of patients succeeded in undergoing a diagnostic examination in the open scanner. There was no correlation between patients who refused to go into both scanners and part of the body under investigation. 5% of investigations could not be completed due to severity of claustrophobia. The largest improvement in success rate was seen in patients who required head examinations. CONCLUSION: Open MRI scanners may be used to successfully scan claustrophobic patients unable to tolerate the investigation in a conventional scanner. These patients agree to go into the scanner and lie still to produce diagnostic quality scans. Some patients will not tolerate an MRI investigation using either type of scanner, irrespective of body-part being scanned.

POSTER 1003

MRI of the claustrophobic patient

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A GE Signa 0.5 T SP™ (General Electric, Milwaukee, USA) interventional magnetic resonance (iMR) scanner was installed at St Mary's Hospital, London in November 1996. PURPOSE: To determine whether known claustrophobic patients tolerate a scan in the iMR unit, when they have failed to complete a scan in a conventional MRI system. MATERIALS AND METHODS: Patients who had attempted and failed MRI in a conventional system were referred to the iMR unit for imaging. Claustrophobic patients who had been subjected to a claustrophobia-inducing experience, previous to their scan request, were also included in the study. Patients were asked to complete a two stage questionnaire; part one was administered before their iMR scan and related to their previous MRI experience. Part two was completed following their imaging experience in the interventional magnet. RESULTS: 50 claustrophobic patients participated in the study. 60% ($n=30$) of the participants were female and 40% ($n=20$) were male, with an age range 26–71 years (mean = 46 years). Various anatomical regions were scanned. 88% ($n=47$) of the participants underwent successful MRI in the interventional machine without extra sedation. 12% ($n=3$) failed imaging in the iMR machine. CONCLUSION: The GE Signa 0.5 T SP® magnet allows successful MRI in 88% of the claustrophobic population; a group of patients previously thought impossible to scan in the MRI environment.

POSTER 1004

Image quality evaluation of a dry digital laser imager for recording high quality digital radiographs

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PURPOSE: To report the results of an image-quality evaluation of digital dry laser hard-copy reproductions of high specification, computed mammography and digital thorax, radiographic images. MATERIALS AND METHODS: The image quality of a Sterling Diagnostic Imaging Helios 1417 "dry" digital laser imager has been evaluated, operating in conjunction with photo-stimulable phosphor computed mammography and selenium-based digital thorax radiography systems. Examinations were collected from both systems and film quality assessed by comparing the Helios films with the state-of-the-art hard-copies currently used. The diagnostic quality of the films was noted in each case and results compiled. RESULTS: The digital laser imager evaluation produced equivalent image quality to that of state-of-the-art laser printers of conventional design, in both digital breast and thorax X-ray imaging applications. CONCLUSIONS: Digital radiographic imaging can be supported by a dry digital printer with no compromises in image quality.

POSTER 1005

An investigation into the cross-infection risk associated with the use of extremity X-ray cassettes

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PURPOSE: To determine if there is a potential risk of cross-infection associated with the use of extremity X-ray cassettes. The primary aim of the study was to establish whether potential pathogens (infection causing bacteria) were present on the patient-contact surface of extremity cassettes and, if so, whether there was any increase in levels over a period of time. MATERIALS AND

METHODS: 20 extremity cassettes were dry swabbed following a specific swab procedure (pre-hycolin swab) and then cleaned using a 2% Hycolin™ solution and re-swabbed (post-hycolin swab) to establish that effective decontamination had taken place. Two cassettes were set aside as a control and the others were put to normal use. The 20 cassettes were again swabbed after 1 and 2 weeks use respectively. RESULT: The data collected from the pre-hycolin, week 1 and week 2 swabs established that potential pathogens were present on the surface of the cassettes. 33% of the cassettes were found to be contaminated with potential pathogens, including MRSA, although there was no significant increase in the number of bacteria between week 1 and 2. CONCLUSION: The patient-contact surface of a cassette can harbour potential pathogens and therefore represents a cross-infection risk. The result of this experiment suggests that approximately a third of all patients undergoing extremity X-rays may be at risk of cross-infection.

Musculoskeletal

POSTER 1101
Bone age assessment—comparison of the Greulich and Pyle and Tanner and Whitehouse (TW2) methods

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PURPOSE: Bone age in children is currently estimated using either the "atlas matching" method of Greulich and Pyle, or the "point scoring system" of Tanner and Whitehouse (TW2). Despite the fact that both methods have been used concurrently for many years, there is no consensus as to whether the two methods give equivalent estimates of bone age. Previous studies have all used relatively small sample sizes and regression analysis, which is inappropriate for this type of study. This study was performed to compare the two methods using a large sample of patients. MATERIALS AND METHODS: 362 consecutive "bone age" radiographs of the left hand and distal radius performed in a large provincial teaching hospital were analysed using the methods of Greulich and Pyle and Tanner and Whitehouse. The "method comparison" statistical technique was used to analyse the data. RESULTS: The 95% confidence intervals for the difference between the two methods are +2.28 to −1.52 years. CONCLUSION: In clinical practice a difference between the two methods of up to 2 years is unacceptably large. This difference would not have been detected if the inappropriate method of regression analysis had been used to analyse the data. We therefore conclude that the two methods do not give equivalent estimates of bone age and would suggest that one method only is used when performing serial measurements on an individual patient.

POSTER 1102
Secondary US screening for developmental dysplasia of the hip: a critical 2 year appraisal

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PURPOSE: To assess the impact of a new programme of joint clinical and US screening for developmental dysplasia of the hip (DDH) in infants prospectively over a 2-year period. PATIENTS AND METHODS: All infants with known risk factors for DDH and those with an abnormal clinical examination at birth, were referred to a DDH clinic for clinical assessment by an experienced orthopaedic surgeon and a dynamic US examination by an experienced consultant radiologist. All infants had an X-ray of the pelvis at 6 months. RESULTS: Of 5063 live deliveries, 168 infants were screened, representing 33/1000. 67% were referred from paediatricians, 20% from health visitors and 13% from general practitioners. 40% had risk factors only, 30% risk factors and an abnormal clinical examination, and 30% an abnormal clinical examination only. 21 infants (13%) had an abnormal US examination, of which 11 were treated in a Pavlik harness with good outcomes initially in nine, two later requiring open reduction. The remainder were observed and returned to normal. During the first year there were four late presenters, (not screened) three of whom required open reduction, with no late presenters in the second year to date. Our late presentation has been halved from 2/1000 to 1/1000 and our operative rate reduced from 1.6/1000 to 1/1000, both still relatively high. CONCLUSION: A secondary screening programme incorporating US is valuable and offers limited benefits in early years if a small, highly-selected group is screened.

POSTER 1103
Bone densitometry in patients with low trauma fractures

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PURPOSE: 68% of patients who sustain a hip fracture have a history of a previous limb fracture. Reduced bone density is a recognized risk factor for fracture. This study aimed to establish the incidence of osteopenia and osteoporosis in patients with limb fractures caused by low-trauma injuries. METHOD: Dual energy X-ray absorptiometry (DXA) of a distal radius and ulna was performed on 119 patients with a limb fracture following a low-trauma injury. Low trauma was defined as a fall from a standing height, or a twisting injury at walking pace. Bone density was classified according to the World Health Organization (WHO) guidelines. RESULTS: There were 83 upper limb and 36 lower limb fractures; 108 females and 11 males; age range 42–89 years, mean 61 years. Osteopenia was recorded in 45 patients (37.8%) and osteoporosis in 18 (15%). No difference was observed between upper and lower limb fracture groups or in differing age groups. CONCLUSION: Patients with low trauma fractures appear to be a self-identifying group with an increased incidence of osteopenia and osteoporosis. The detected rates in this study were three times the expected rates of 11% and 5% respectively, indicated by WHO guidelines. Forearm DXA has a good correlation with bone density at other sites. Greater awareness of the association between low trauma fracture and reduced bone density should facilitate earlier lifestyle changes and, where necessary, treatment for osteopenia and osteoporosis.

POSTER 1104
A comparison of MRI, qualitative US and dual energy absorptiometry for the prediction of cancellous bone elasticity *in vitro*

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PURPOSE: To compare MRI, quantitative US (QUS) and dual energy absorptiometry (DXA) as predictors of the Young's modulus (E) of cancellous bone *in vitro*. MATERIALS AND METHODS: 11 cubes of cancellous bone (six human and five bovine) were harvested. Mechanical testing was performed to determine E in the three orthogonal directions. Specimens were defatted and their apparent density (ρ) measured. A single value of bone mineral concentration (BMC) and density (BMD) was measured for each cube. Ultrasonic velocity (v) and attenuation (BUA) were determined in the three orthogonal directions and MRI obtained in three orthogonal planes. RESULTS: Including data from all cubes and all directions ($n=33$), ρ explained 75.5% of the variance in E, BMD 66.7% and BMC 39.6%. v and BUA (bovine cubes only; $n=15$) were less good at explaining variance in E compared with either of the density measures (ρ and BMD) for those cubes ($R^2_\rho=89.4\%$; $R^2_{BMD}=81.8\%$; $R^2_v=55.4\%$ and $R^2_{BUA}=61.9$. MRI demonstrated excellent resolution of internal cube structure and clearly showed the anisotropic arrangement of trabeculae which results in the orthogonal variation in Young's modulus. Quantification of structural anisotropy in these specimens by stereological analysis of the MRI images and T_2^* measurements will be presented in full. CONCLUSIONS: Density alone is a moderately good predictor of E in these specimens, whereas QUS measurements are relatively poor. MRI can directly measure structural variation in cancellous bone, providing an alternative measure of mechanical competence.

POSTER 1105
Assessing the cortical structure in high resolution CT images of lumbar vertebrae by evaluating the cortical profile

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PURPOSE: To introduce a new, easily obtainable parameter for the gradation of structural changes in the cortical shell, caused by osteoporosis, which is based on high resolution CT (HRCT). MATERIALS AND METHODS: One HRCT slice (2 mm thick) from the mid-vertebral section was obtained in 22 lumbar vertebrae from five cadavers with different degrees of demineralization. Cortical bone mineral density (cBMD) was determined using single energy quantitative CT/85 kV and an automated contour-finding program (Somatom DRH). In the HRCT image, the cortical ridge—the central part of the corticalis with the highest density values—was determined using an automated contour-tracking program. The grey-value profiles of the cortical ridge (the intensity values as a function of the relative position) were analysed by

counting the number of intersections n_i with a variable horizontal line. RESULTS: The number of intersections shows a characteristic local maximum n_{imax}, when the horizontal line is positioned slightly below the average cBMD. The averaged maximum number of intersections is 38% higher in the osteoporotic cases than in the non-osteoporotic ones. The correlation coefficient between the maximum number of intersections n_{imax} and the cBMD of each vertebra is -0.79 ($p<0.0001$). CONCLUSION: HRCT images of the cortical shell show structural properties which can be used to distinguish between different degrees of osteoporosis. The presented parameter allows the gradation of structural properties and is independent of BMD.

POSTER 1106

Tuberculous spondylitis: radiological diagnosis and management

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INTRODUCTION: Tuberculous spondylitis (TBS), first described in 1779, has a worldwide distribution and a high prevalence in developing countries. PATIENTS AND METHODS: This paper reviews the clinical course of 10 patients with a diagnosis of TBS who were treated at the Mater Misericordiae Hospital during a 4 year period to April 1997. There were five males and five females, with an age range of 54 ± 4 years. CT and MRI were performed in nine and seven patients respectively to assess the extent of disease. RESULTS: Six patients had abnormal findings on plain radiographs, suggesting an infectious spondylitis. In contrast, cross-sectional imaging using CT and MRI were abnormal in all patients. Six patients had involvement of the thoracic spine while the remaining four patients had lumbar spine involvement. Only three cases had concurrent extra spinal tuberculous disease. In nine of the 10 cases, the diagnosis of TBS was confirmed by culture or histology. In seven patients, aspirates obtained under CT, or fluoroscopic guidance, yielded a diagnosis, while two patients had confirmation of the diagnosis surgically. In five patients definitive drainage of adjacent paravertebral abscesses was achieved radiologically. CONCLUSION: TBS is still prevalent in Ireland in non-HIV infected patients. Plain radiography is important and central to the diagnosis, but was helpful in only slightly over half of the study group. CT and MRI were, however, abnormal in all patients and therefore should be performed early in patients at risk for tuberculous infection with thoracolumbar pain or neurological signs.

POSTER 1107

Imaging of dislocation of the sternoclavicular joints

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Dislocation of the sternoclavicular joint is an uncommon injury, accounting for only 2–3% of all dislocations of the pectoral girdle. The rarity of the injury, together with the difficulty of both clinical and radiological detection, may lead to a delay in diagnosis. On plain radiographs the diagnosis is suspected from asymmetry of the medial ends of the clavicle. Anterior dislocation is believed to give superior displacement and posterior dislocation inferior displacement of the clavicle. MATERIALS/METHODS: A retrospective review of six cases (four posterior, two anterior) of dislocation of the sternoclavicular joint; the plain radiographic and CT findings are illustrated. In one case of posterior dislocation the clavicle was displaced superiorly. Diagnosis was delayed in all cases (mean delay between injury and diagnosis 3 weeks). CONCLUSIONS: There should be a high index of clinical suspicion for the diagnosis of sternoclavicular joint dislocation. Plain radiographic findings can be subtle and do not reliably distinguish anterior and posterior dislocations. CT is the investigation of choice. Delay in diagnosis is associated with patient morbidity and difficulty in obtaining a stable reduction of the sternoclavicular joint.

POSTER 1108

Distal forearm fractures in children: the role of radiographs during follow-up

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PURPOSE: There is no consensus on the frequency of radiographic examination in the routine follow-up of distal forearm fractures in children. This study was undertaken in an attempt to rationalize and optimize the use of ionizing radiation in these circumstances. MATERIALS/METHODS: The radiographs and clinical notes from all distal forearm fractures in children who were admitted during 1992 were retrospectively studied. Degrees of initial angulation were measured from all of the radiographs performed during follow-up. Comparisons of outcome were made between the fractures with initial angulation $<10°$ and $>10°$; types of fracture and the degree of reduction. RESULTS: There were 325 distal forearm fractures in children in the study period. Fractures with initial angulation of $<10°$ had no clinically significant evidence of reangulation and should be considered stable, requiring only an initial, diagnostic, radiograph. Complete fractures, displaced fractures and fractures involving both the radius and ulna require more careful follow-up. Residual angulation after manipulation under anaesthetic (MUA) of 5–10° was not associated with an increased rate of reangulation in this study. CONCLUSION: There is no apparent advantage in performing more than three radiographs in the majority of cases. The authors make recommendations concerning the optimal frequency of radiography in the follow-up of forearm fractures in the paediatric population.

POSTER 1109

Degenerative joint disease: can it start with abnormal ossification of the medial tibial epiphysis?

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This study aimed to determine the earliest quantitative morphological changes in joint tissues which may lead to osteoarthritis (OA). It is extremely difficult to determine early tissue changes in patients and therefore the STR/ORT mouse was selected for a detailed study. This mouse develops degenerative joint disease in the knee at an early age, showing typical radiological morphological and histochemical changes. 440 coronal sections of CBA and 720 STR/ORT mice were subjected to histomorphometric analysis on a Joyce Loebl Magiscan image analyser. The total area occupied by trabecular bone, as compared with the marrow, was measured for the medial and lateral compartments of the tibial epiphysis. The results show that the pattern of ossification in the proximal tibia in the STR/ORT mouse is greater than that of the normal CBA mouse. In the STR/ORT mouse there is increased bone formation in the medial compartment, compared with the lateral compartment. Differential ossification increases with age. It appears to begin at birth and steadily progresses until there is >90% ossification of the epiphysis in some individuals. The study also points to chondrogenic changes appearing at approximately 2 months, which then follow a progressive deleterious route until full eburnation occurs in the most severely affected specimens by 9 months. The study indicates that subchondral bone can be the site for the initial lesion for OA.

POSTER 1110

Spiking of the tibial spines: is this a useful sign of early knee joint osteoarthritis?

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PURPOSE: To determine whether spiking of the tibial spines is an early sign of osteoarthritis (OA) of the knee. METHOD: Two groups were assessed. Radiographs of 10 consecutive patients from each decade (3rd–10th) were collected from accident and emergency department attenders with trauma (fractures excluded). The second group comprised radiographs of consecutive patients referred with chronic knee pain for orthopaedic assessment. There were 70 radiographs in the first group (five males, five females from each decade) and 53 radiographs in 42 patients (30 males, 12 females) in the second group. Measurements of the angle of each tibial spine and the ratio of tibial spine height to tibial plateau width were calculated. The second group were also assessed for OA in the intercondylar notch using tunnel views. Unpaired *t*-test was used for analysis. RESULTS: The only difference demonstrated between the patients with OA and the controls involved the lateral spine. In the first group the lateral angle was more spiked with OA (114 *vs* 86 $p<0.001$). In the second group the lateral spine was taller with OA (0.14 *vs* 0.13 $p<0.05$). With radiographic evidence of OA in the intercondylar notch on tunnel view all had radiographic evidence of OA elsewhere in the knee. If there was no evidence of OA in the notch there was none on other views either. CONCLUSION: Our findings suggest that, although there may be an association of spiking of the lateral tibial spine with established OA, spiking of the tibial spines alone is not an early indication of OA.

POSTER 1111

Protrusio acetabuli in Marfan's syndrome

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Marfan's syndrome is an autosomal dominant multisystem disorder of connective tissue, which often involves the cardiovascular, ocular and skeletal systems. Revised criteria for diagnosis of Marfans (De Paepe et al, 1996), regards skeletal involvement as a major criterion if at least four of eight typical skeletal manifestations are present, one of which is protrusio acetabuli (PA). We measured the prevalence of PA in the known Marfan's population in the Grampian region. The pelvic X-rays of 18 Marfan's patients and 18 controls were analysed. Using Kulman's criteria (*Radiology*, 1978), PA was determined by the presence of an acetabular line lying medial to the ilioishial line (by 3 mm or more in men, and 6 mm or more in women), in addition to one of the following: a centre-edge angle (of Wiberg) of 40 degrees or more, or crossing of the teardrop (of Kohler) by the ilioishial line. PA was present in 44% (8/18) of patients with Marfans, compared with 6% (1/18) of controls ($p = 0.018$, Fischer's exact). Using the revised criteria, the presence of PA would have affected the final diagnosis of Marfan's syndrome in only one patient out of 18. Therefore, we suggest that, rather than a pelvic X-ray being performed routinely, this is reserved for those cases in which the presence of PA will alter the final diagnosis. Our results suggest that the acetabular line position is the most reliable measurement and we advocate the use of this simple technique for the diagnosis of PA from plain films.

POSTER 1112

The diagnosis of Morton's neuroma: a cost-effective approach

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PURPOSE: MRI has been shown to be a sensitive method of detecting symptomatic Morton's neuroma (MN). It is our feeling that US has an important role to play in these patients and this study compares US with MRI in patients suspected of having MN. METHOD AND MATERIALS: 21 patients with suspected MN referred for MRI were also imaged using US. The US examinations were undertaken by a musculoskeletal radiologist, unaware of the MRI findings. The effect of experience on lesion detection was assessed by comparison of performance between years 1 and 2 of the study. RESULTS: In year 1, 10 patients were examined, a total of 17 MN were seen on MRI, three of which were also seen on the US (18%). In year 2, 11 patients were examined and of the 16 MNs seen in total on MRI, 15 were seen on US (94%). Five patients had bilateral neuromas in the same interspace and one patient had neuromas in adjacent interspaces. CONCLUSION: There is a steep learning curve in the US detection of MN but, despite their size, detection rates can approach that of MRI. US is readily available and less costly than MRI and should be offered as a first-line investigation for MNs. MRI should be reserved for US-negative patients where the clinical suspicion of MN remains high.

POSTER 1113

The significance of knee joint effusion detected on radiographs reported for general practitioners

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Radiography has been shown to be accurate in diagnosing knee joint effusion and more sensitive than clinical examination. Previous research suggests that 32% of knee effusions are not clinically suspected prior to referral from general practice. There is no published work on the significance of knee joint effusions detected on radiographs performed for general practitioners (GPs) outside the acute trauma setting. In an audit of 1153 knee radiographs 121 knee effusions were noted, 56 as an isolated finding. These cases had 2 year follow-up. The sensitivity and specificity of clinical examination against a radiograph control was 66% and 74%, respectively. In 31% the report of a knee effusion resulted in a change of management and further investigation, but in a further 35% further investigation was instituted only when symptoms failed to settle. In many cases, further investigation revealed a treatable process. In the group with meniscal tear, 67% were initially given reassurance based on the knee radiograph report of effusion. Our experience suggests that small knee effusions on radiographs are not always reported, also this data shows knee effusions may not be detected clinically by GPs. Although many patients settle without treatment or diagnosis being made, the presence of effusion commonly implies an underlying condition. We conclude that knee radiographs should be carefully studied for evidence of effusion and this should be reported as a positive sign.

POSTER 1114

MRI assessment of the prevertebral space in acute cervical spine trauma

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Thickening of the prevertebral soft tissues is an important sign of acute cervical spine trauma. Plain film assessment is limited by the wide range of normal variation at the level of C1 and in the lower cervical spine, and the displacement of soft tissues by osteophytes. MATERIALS AND METHODS: Plain films and MRI (1.5 T, IGE Signa) of 23 patients with acute cervical spine injury were retrospectively reviewed and the pre-vertebral soft tissues were assessed. There was a mean delay of 3 days between the injury and MRI. RESULTS: MRI showed prevertebral haematoma in 17 cases; only seven patients had prevertebral soft tissue thickening on the initial plain films. Odontoid fracture, atlantoaxial dislocation, hyperextension sprain, teardrop and compression fractures are illustrated. In conclusion, haematoma in the prevertebral space appears as a bright signal on T_2 and intermediate signal on T_1 images. Conspicuity is helped with fat-suppressed T_2 images. MRI is particularly helpful at the craniovertebral junction and in the lower cervical spine, areas where plain film interpretation is difficult.

POSTER 1115

Pain drawings in the assessment of nerve compression: a comparative study with lumbar spine MRI

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PURPOSE: To assess the ability of the pain drawing in predicting the presence of nerve root compression on lumbar spine MRI. METHODS: The pain drawing consists of front and back outlines of the body on which patients mark areas of abnormal sensation with different symbols to represent ache, pain, pins and needles and numbness. Most research work has concentrated on the ability of the pain drawing to act as a screening method for psychological distress, with less work directed at the influence the anatomical abnormality has on the pain drawing. 134 consecutive outpatients, attending for lumbar MRI in the investigation of back and leg pain, completed pain drawings and psychological testing immediately prior to the examination. The pain drawing was analysed by previously reported criteria and the MRI independently assessed for the presence of nerve compression by three radiologists. Multivariate stepwise discriminant analysis was used to identify patients with nerve compression on the basis of their pain drawing. RESULTS: Nerve compression was predicted by numbness in the anterolateral aspect of the foot. There was considerable overlap in the appearances of the pain drawing between patients with and without nerve compression and the pain drawing correctly classified only 58% of patients with nerve compression. CONCLUSIONS: The pain drawing is not a good predictor of nerve compression on MRI in a group of patients investigated for back and leg pain. It should be interpreted with caution and in the light of the full clinical picture.

POSTER 1116

Optimization of MRI pulse sequences to visualize the pars interarticularis

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PURPOSE: MRI may be a useful means of detecting acute pars stress fractures. However, recent publications have highlighted the deficiencies of routine MRI in evaluating the pars interarticularis. 15 asymptomatic volunteers had optimized MRI examinations of the lumbar spine. METHOD: MRI examinations were performed with 3 mm sagittal and reverse angle T_1 weighted images, and 3D sagittal gradient echo images, on a 1 T Siemens system. Each pulse sequence was evaluated in isolation. The pars was determined to be normal, sclerotic, equivocal or not demonstrated, or had a definite defect. RESULTS: 150 pars were evaluated. 59% were deemed definitely intact on the sagittal T_1 weighted images (continuous marrow throughout the pars), but 84% were deemed intact when the sagittal and reverse angled T_1 weighted images were reviewed together. 16% were sclerotic, with combined sagittal and reverse angled T_1 weighted images. However, the majority of pars defects occur at

L4/L5 and 85% of these were intact on the sagittal T_1 weighted sequence alone. The 3D GE sequence was less useful with only 46% intact pars (57% at L4/L5). No definite pars defects were identified on any pulse sequence. CONCLUSION: Improved visualization of the pars interarticularis is achieved by utilizing optimized protocols. It will be helpful to compare CT with MRI to assess the significance of sclerotic pars, and it will also be necessary to evaluate MRI of acute stress injuries utilizing fat saturation T_2 weighted or STIR sequences to detect associated marrow oedema.

POSTER 1117

Imaging of vertebral haemangiomata causing spinal cord compression

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PURPOSE: To illustrate the appearance at MRI of vertebral haemangiomata causing spinal cord compression. INTRODUCTION: Haemangiomata have a characteristic appearance at CT and the diagnosis may be made on plain radiographs if the lesion is extensive. However, in many patients with spinal cord compression, the primary investigation is MRI. Asymptomatic vertebral haemangiomata have typical MRI characteristics because of their high fat content. However, compressive haemangiomata may have a less typical MRI appearance which can cause diagnostic difficulty. PATIENTS AND METHODS: The MRI of three patients who presented with spinal cord compression and proceeded to surgery with a histological diagnosis of haemangioma is reviewed. RESULTS: In all three patients, MRI showed very high signal intensity on T_2 weighted images and low or iso-intense signal on T_1 weighting. In one patient the diagnosis was suggested at MRI preoperatively, but a definite diagnosis could not be made in the other two cases. In all three cases, plain films and/or CT were typical of haemangioma. CONCLUSIONS: Compressive vertebral haemangiomata have atypical MRI signal characteristics and may resemble metastases, or other malignant lesions of bone. However, very high signal intensity on T_2 weighted images suggests the possibility of haemangioma and the correct diagnosis is readily made using CT.

POSTER 1118

Imaging of spinal metastatic and infiltrative disease

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PURPOSE: To assess correlation between histology and MRI signal characteristics and to compare imaging with MRI and bone scintigraphy. METHODS: 120 MRI scans, which showed malignant spinal disease, were reviewed retrospectively by two consultant radiologists. Signal characteristics were correlated with histology, where known. 47 of these patients had also had bone scans and comparison between the two techniques was made. RESULTS: No significant differences in signal characteristics were found between scans of different histologies. The majority of lesions had low T_1 and mixed or high T_2 signal. This included those originating from the prostate, where sclerotic lesions are expected to have low signal on both T_1 and T_2. Comparison between MRI and bone scintigraphy confirmed the greater sensitivity of MRI in detecting an additional three or more vertebral bodies in >75% and in seven cases the bone scans were interpreted as entirely normal. In three cases, however, MRI was normal when isotopes detected both spinal and peripheral lesions. CONCLUSION: Histology cannot be predicted from MRI characteristics. Although MRI detects more lesions than bone scintigraphy, the latter still has a role, particularly in detecting peripheral lesions.

POSTER 1119

Dynamic gadolinium enhancement profiles of sacroiliitis on a 1.0 T Siemens MRI system

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PURPOSE: To develop a simple technique on a 1.0 T Siemens MRI system using gadolinium profiles for the diagnosis of sacroiliitis. METHOD: 15 patients with known inflammatory sacroiliitis underwent dynamic enhanced scanning of the sacroiliac joints (SIJs) using a T_1 weighted TurboFLASH sequence in the paraxial plane with a circularly polarized phased array coil (parameters TR 11.0 ms, TE 4.2 ms, flip angle 15°, 64 slices, 5 mm slice thickness, time 7 min 14 s). 10 patients who were having gadolinium enhanced scans of the spine for other purposes acted as a control group. Several small circular regions of interest (ROI) were drawn over the SIJs and compared with a large irregular ROI incorporating the whole of the SIJ. Care was taken to include only the synovial joint. Gadolinium enhancement profiles for each joint were produced. The percentage increase in signal intensity and the enhancement gradient were recorded. RESULTS: The large ROI showed less variation than the small ROIs and was quicker to perform. The average post-processing time was 5 min. The enhancement gradient consistently differentiated between the two groups. CONCLUSION: Using this combination of MRI system, sequence and post-processing technique provides a simple method of assessing the SIJs. It should prove a useful tool in the diagnosis of sacroiliitis.

POSTER 1120

Elastofibroma dorsi: a radiological diagnosis

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Elastofibroma dorsi is a tumour-like lesion of the subscapular region, thought to have a mechanical aetiology. The MRI findings are characteristic. Appearances are similar on both T_1 and T_2 weighted images, consisting of mixed areas of high and low signal reflecting the histological findings of fat, interspersed in a predominantly fibrous matrix. We present the MRI findings in three cases with histological correlation. We discuss the differential diagnoses and conclude that diagnosis may be made on imaging grounds alone, if the lesion is in a typical site.

POSTER 1121

Arthroscopy and low field strength MRI in the investigation of anterior knee pain

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A non-invasive investigation which can exclude chondromalacia patellae (CMP) is desirable because most patients with anterior knee pain do not require surgery. We compared low field strength MRI and arthroscopy for the diagnosis of CMP. 38 patients (48 knees) with symptoms suggestive of CMP entered the study. Scans were sequenced to enhance visualization of the patellofemoral joint. Arthroscopy was performed without knowledge of the MRI findings. 30 scans showed no evidence of CMP and, of these, 21 had negative arthroscopy. The negative predictive value was therefore 70% and specificity 75%. Positive predictive value was 61% and specificity was 55%. This study shows that low field strength MRI can exclude CMP in 70% of cases and may reduce the need for arthroscopy in the diagnosis of this condition.

POSTER 1122

The MRI features of early synovial chondromatosis

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PURPOSE: The majority of cases of synovial chondromatosis are readily diagnosed in the chronic phase, with a combination of intra-articular loose bodies and degenerative joint disease. Early cases, however, in the proliferative phase may be mistaken clinically and radiologically for a neoplastic process. This poster illustrates the MRI features of seven such cases. METHODS: The MRI examinations of seven patients referred to two units with phase one or two (Milgram, 1977) histologically-proven synovial chondromatosis were retrospectively reviewed and compared with other available imaging studies. RESULTS: Six cases presented with the clinical diagnosis of a soft tissue tumour and the seventh with an arthritic process. Five of the patients were male, two were female, with an age range of 35–76 years, mean age 57 years. Three cases arose in the knee joint, two in the hip joint and one each respectively in the elbow and acromio-clavicular joints (six of the cases demonstrated calcification within the soft tissue masses on the conventional radiographs). All showed synovial masses arising from the joints on the MRI images, varying in size from 3 to 20 cm, mean 11 cm. The MRI demonstrated bone erosion in five cases. In one case, the elbow, there was histological evidence of malignant change to a low grade chondrosarcoma, a rare but well-recognized entity. The MRI features in this case were indistinguishable from the other cases of synovial chondromatosis. CONCLUSION: In the early proliferative phase, synovial chondromatosis can be easily mistaken for a neoplastic process. This condition should be considered in the presence of a calcifying synovial mass with bone erosion.

POSTER 1123

The MRI appearances of soft tissue expanders used in the management of musculoskeletal sarcomas

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PURPOSE: Soft tissue expanders may be inserted into the body cavities to displace radiosensitive organs out of the radiotherapy treatment field. This is a technique which has had widespread use for many years but, with the increase of MRI to monitor disease progression, there is a need to be able to differentiate between soft tissue expanders and pathology. MATERIALS AND METHODS: Seven patients referred to an orthopaedic oncology centre with musculoskeletal sarcoma, six pelvic and one retroperitoneum, required radiotherapy as part of their treatment. All had a soft tissue expander (Nagosil) inserted prior to commencement of radiotherapy. 15 scans were retrospectively reviewed. The examinations were performed on a 1 T super-conducting magnet, using the body coil to obtain T_1 weighted, T_2 weighted FSE and STIR sequences in at least two orthogonal planes. RESULTS: In the absence of an appropriate clinical history, the MRI appearances of the soft tissue expanders can be mistaken for pathological fluid collections, such as abcesses and post-operative seromas, or even recurrent tumours. If in doubt, the subcutaneous valve used to facilitate filling whilst *in situ* can be identified on MRI as a small metal artefact. A recent modification has omitted the usual, integral stainless steel backplate in order to minimize artefact and the potential heating effect associated with MRI. The expander can be differentiated from recurrence/residual tumour with the use of gadolinium. CONCLUSION: The MRI appearances of soft tissue expanders can cause confusion to the unwary. This scientific exhibit illustrates the typical appearances of soft tissue expanders and the pathological processes for which they may be mistaken.

POSTER 1124

MRI in assessing the pelvic anatomy following hindquarter amputation

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PURPOSE: Following hindquarter amputation, the resulting loss of pelvic symmetry and migration of organs into atypical sites can make the assessment of the post-operative "normal" anatomy difficult. This study reviews the normal and abnormal MRI appearances of the pelvis, post-hindquarter-amputation. METHOD: A retrospective study of MRI scans of patients who have undergone hindquarter amputation for advanced musculoskeletal pelvic malignancy. Scans were performed on a 1.0 T Siemens machine. All scans were reviewed with particular emphasis on the change in pelvic symmetry, surgical scar and presence or absence of recurrent tumour. RESULTS: There were 13 patients (nine male and four female) with an age range of 31–71 years (mean 47 years). A total of 55 MRI scans have been performed to date, range of 2–10 per patient (mean four scans per patient). Post-operative muscle flap oedema, seromas, displacement of bladder and bowel to the side of surgery and tumour recurrence will be shown. Gadolinium-enhanced MRI was used to characterize soft tissue masses within the pelvis more accurately than with CT. CONCLUSION: An understanding of the normal pelvic anatomy post-hindquarter-amputation is essential to the accurate ientitification of tumour recurrence.

POSTER 1125

Comparison of MRI sequences in quantifying *in vitro* cartilage degeneration in osteoarthritis of the knee

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OBJECTIVE: MRI of human knee cartilage was performed to determine optimal sequences for the depiction of articular cartilage. DESIGN: 24 amputated knees were examined with eight different sequences in a 1.0 T imager. These sequences were optimized by a pilot study. Each cartilage lesion was graded from one to four (Outerbridge staging system). Subsequently, the results of each sequence were compared with the macroscopic findings and statistically tested against each other. RESULTS: The FLASH-sequence (TR = 50 ms) with combination of flip angle of 40° and echo time of 10 ms and the FISP-sequence (TR = 40 ms) with combination of flip angle of 40° and echo time 11 ms were best for depiction of cartilage structure and internal detail. No significant difference was demonstrated between fat-saturated (FS) 3D FLASH and FS 3D FISP ($p = 0.05$). These FS 3D sequences were significantly better than sequences without fat saturation ($p = 0.05$). There was no significant difference between MT 3D FLASH, MT 3D FISP and 3D FISP. All 3D sequences showed significantly ($p = 0.05$) better results than SE or FSE sequences. The T_1 weighted SE pulse sequence was significantly ($p = 0.005$) better than the T_2 weighted TSE sequence. Fast T_2 weighted spin echo (FSE) was not suitable for early and accurate detection of cartilage lesions.

Oncology

POSTER 1201

CT imaging of malignant melanoma

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PURPOSE: To evaluate and determine the incidence of metastatic sites displayed by CT in a population with malignant melanoma. MATERIALS AND METHODS: The CT studies of 100 consecutive patients with malignant melanoma over a 2 year period were reviewed. Sites and frequency of involvement by metastatic deposits were recorded. RESULTS: 80% of the study population had evidence of metastatic disease. The percentage of sites/systems involved by metastasis were as follows: regional lymph nodes 41%; central nervous system 27%, of which CSF metastasis constituted 1%; pulmonary 18%, of which pleural metastasis constituted 3%; liver 17%; skeletal 8%; spleen 7%; gastrointestinal 5%; mesentery 4%; subcutaneous/skin 4%; adrenal 2%; and renal 1%. Less common involvement occurred in the maxilla, hard palate, mandible, intraparotid, thyroid, tonsillar and intramuscular locations. CONCLUSION: The incidence of and sites affected by malignant melanoma in this study are in broad agreement with other studies. A pictorial review of unusual locations is presented.

POSTER 1202

Radiological characteristics of extramedullary plasmacytoma in the head and neck

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PURPOSE: Extramedullary plasmacytomas (EMP) are tumours of plasma cells, 80% of which occur in the head and neck. Accurate diagnosis and demonstration of tumour extent are necessary as most of these tumours respond to radiotherapy. This study illustrates the MRI and CT features of EMP in the head and neck, which might help differentiate these lesions from other tumours in this region (carcinoma, lymphoma, melanoma). METHODS: Patients were imaged using a combination of plain film radiography, pre- and post-contrast CT and MRI. For MRI, T_1 weighted images were obtained in at least two orthogonal planes. RESULTS: At this institution, a series of 25 cases of EMP of the head and neck have been treated over a 20 year period (male : female 21 : 4). The majority of tumours originated in the nasal cavity, paranasal sinuses, tonsil or pharynx ($n = 20$), or larynx ($n = 3$), with one each in the parotid gland and middle ear. Definite bone destruction was apparent in only five patients and associated adenopathy in only two patients. On cross-sectional imaging, the lesions were well demarcated and showed notable enhancement following iv contrast. The tumours demonstrated homogenous morphology and surrounding structures were displaced rather than infiltrated, presumably reflecting the slow growth rate of these lesions. CONCLUSION: The imaging characteristics described above should alert the radiologist to include EMP in the differential diagnosis of extracranial head and neck tumours.

POSTER 1203

MRI of tumours involving the perineum: imaging anatomy, staging, treatment evaluation and surgical correlation

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Tumours involving the perineum are relatively rare. The multiplanar and soft tissue contrast capabilities of MRI enable excellent demonstration of the complex anatomy of this region. Local staging and an assessment of the involvement of critical structures in the perineum are important determinants of potential resectability and the anticipated morbidity of surgical resection of such tumours. Illustrative cases have been drawn from our experience of over 20 patients who have had MRI evaluations. The spectrum of diseases includes carcinomas of the urethra and penis, angiomyxoma, desmoid tumour, chondrosarcoma and a wide range of soft tissue sarcomas involving the perineum. The key anatomical structures of

clinical importance, with particular reference to surgical evaluation, and the principles of staging will be illustrated. Optimal MRI to evaluate individual structures in the perineum will be suggested. The accuracy of MRI staging, in the subset of those patients who had surgical resections, will be presented. The role of MRI in assessing treatment response, for example, pre-operative down-staging of tumours and follow-up evaluation of unresectable lesions, will also be presented.

POSTER 1204
Withdrawn

Physics

POSTER 1301
Withdrawn

POSTER 1302
Evaluation of respiratory motion correction techniques in MRI
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INTRODUCTION: The effect of respiratory motion in 2DFT MRI images causes ghost artefacts, with a loss of local spatial resolution. MagNET, the UK Magnetic Resonance Evaluation Team are investigating a motion phantom and analysis techniques for the comparison of respiration correction techniques offered by different manufacturers. METHODS: The motion phantom consists of an air-driven piston with a fixed pushrod and attached fluid phantom container, filled with fat mimicking gel in order to eliminate artefacts due to fluid motion. The motion of the piston was designed to simulate respiration using an air regulator. The movement of the phantom was calibrated and evaluated for reproducibility. RESULTS: Images were compared from MRI scanners of the same field strength, but from different manufacturers. An image analysis technique, based on the autocorrelation function, has been developed by MagNET to quantify the degree of degradation in image quality caused by motion artefacts. Also, κ-space data from these images were evaluated with the use of the Lomb–Scargle periodogram. The 2D κ-space matrices were reduced to single 1D arrays of data points, thus treating the FID signals in the data as a single time-series signal, unevenly sampled. This "signal", together with the corresponding observation times, constituted the input to the normalized Lomb–Scargle periodogram. Both image analysis techniques provided measurements for the comparison of the different motion correction techniques. CONCLUSION: It is intended that the results from this work will enable a set of protocols, test objects and analysis techniques to be chosen for the evaluation of motion correction techniques in MRI.

POSTER 1303
Development and assessment of cubic test-objects for the evaluation of dedicated MRI systems
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PURPOSE: Test-objects used to evaluate the performance of MRI systems are typically designed for the head field-of-view of whole-body systems. This study aimed to develop a set of test-objects suitable for evaluating the performance of dedicated MRI systems. METHOD: A modular approach was adopted in designing the test-objects. The set comprises five cubic test-objects: a flood-field, slice-width, contrast, bar resolution and modulation transfer function block. Each cube is of length 70 mm. The objects can be used singly, or in combination. Test-object holders were constructed to position the test-objects in different arrangements. Trial studies were performed on the knee-coils of two clinical MRI systems using two different test-object combinations. Image sequences were based on the standard UK Magnetic Resonance Evaluation Team (MagNET) protocol using the following parameters: TR = 1000 ms, TE = 30 ms, matrix size 256 × 256, field-of-view 250 mm, slice-thickness 3 mm and NSA = 1. RESULTS: The trials performed on the two systems yielded promising results. Uniformity, signal-to-noise ratio (SNR), geometric distortion and linearity, slice-width, resolution and contrast tests were evaluated. CONCLUSIONS: MagNET have developed a unique set of test-objects to meet the requirements of performance evaluation for dedicated systems. The images obtained on clinical systems confirm the viability of the modular approach. MagNET aim to use these test-objects in the type-test evaluations of dedicated MRI systems.

POSTER 1304
Comparison of regional and global tissue registration to minimize artefacts in T_1 based temperature measurements
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PURPOSE: To improve the consistency of *in vivo* T_1 values used as the basis of temperature measurement in MRI. INTRODUCTION: T_1 measurement is the most practical method for the monitoring of temperature in low field open magnets. It is, however, very vulnerable to partial volume effects and movements of tissue relative to the positions established for regions of interest (ROIs). We compared the performance of adjusting ROI positions based on the use of registration of a whole area of the body compared with that of much more localized registration as a means of avoiding these. MATERIALS AND METHODS: Temperature in the calf muscle of a volunteer was cycled using water bags and the temperature at various places in the leg predicted using a thermoheat equation model. Long TR and short TR GRE images with a TE of 20 ms were acquired at 1.5 T throughout the experiment. ROIs were selected and the T_1 values recorded. The long TR images were segmented to remove subcutaneous fat and the remaining data was registered against a starting image. The ROIs were then segmented again, to give small local regions which were then registered, with T_1 data calculated from them. RESULTS AND DISCUSSION: Overall segmentation resulted in a mean error of 2.90 °C (±0.60 °C),

local segmentation resulted in a mean error of 1.72 °C (±0.60 °C). There is significant improvement between the two, although the latter process is substantially more demanding.

POSTER 1305

Is correction of distortion important for diagnostic MRI?

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PURPOSE: Image distortion is important in MRI. Accurate measurement is necessary for planning intervention, such as biopsy, radiotherapy, laser ablation or surgery, particularly when the information is used remotely. The distorted image may be taken as a true record and false measurements taken. Distortion can also cause local alteration in signal intensity, which may result in a false positive report of an abnormality. METHOD: A purpose-made phantom was used to assess the geometric distortion on four different MRI machines. These were the Siemens 1 T expert, the Siemens 0.2 T open scanner, the IGE Vectra, and the Philips 1.5 T. The phantom was constructed using Perspex sheets with regular hemispherical indentations. The sheets were bolted together under water with plastic bolts and water was trapped in the spherical holes made between the adjoining hemispheres. The phantom was scanned using a variety of commonly used sequences on all the various machines. Turbo spin echo, T_1, T_2 and Turbo STIR were scanned on all machines. In addition, sequences specific to a machine were also scanned. The distortion was measured against the known geometry of the phantom. RESULTS: On all machines it was found that distortion at the centre of the field of view was considerably less than at the periphery. Distortion at both the edges of the image and at the end and beginning of a series occurred. CONCLUSION: Image distortion is significant on diagnostic MRI and differs on different machines at different field strengths and sequences.

POSTER 1306

Precision small field dosimetry, do multileaf collimators shape up?

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This research aimed to establish whether multileaf collimators (MLCs) were capable of controlling the shape, and hence the dosimetry, of small fields for use initially in dose escalation and boost regimes. Special customised devices for small fields were not included as the work was to be focused on basic universal field units, such as Philips, GE and Varian, with a minimum blade width of 1 cm. The work so far has been carried out on a Philips SL18 Linear Accelerator with an integral MLC; its construction and the geometric position of the MLC relative to the target made it the ideal test bed. The largest field size used was 5 × 5 cm and the smallest, 2 × 2 cm. Inside this work area a range of shapes were created: circles, triangles at various collimator angles for worst case scenario, cut-off corners, opposed corners etc. Shapes were created using both the side and the tip of the blade to obtain maximum control. Some of the shapes were deliberately selected so that they did not fit a full blade width. This meant over- or under-shielding the volume, unless techniques could be applied to improve contour control. Customised blocks were manufactured of these same shapes and data collected using both water tank and film grids. The detectors used were 0.125 cm volume ion-chambers and diodes. The results showed that a single MLC field is not able to create accurate small-shaped fields, unless that shape fits the blade width perfectly and the overall contour required is straight-edged. The main limitation is the blade width. The error in contour control, *i.e.* volume incorrectly treated, can be as much as 40%. The customised blocks, which in this example should have fitted the 50% isodose, were quite inaccurate and, even with the simplest shape, it was typically 80%. The block manufacturing device that we have in use is unable to produce small, open-shaped fields. By applying some simple techniques, still using the MLC as stand-alone, *i.e.* with no external blocks or attachments, and with no increase in treatment time, we were able to create all the required shapes using the MLC up to a 95% isodose. These techniques can be applied to all MLCs regardless of field size.

POSTER 1307

An investigation of the effects of multileaf collimator leaf calibration variability upon intensity modulated beams

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PURPOSE: Intensity-modulated radiotherapy can be achieved by driving the leaves of a multileaf collimator across an X-ray therapy beam. Algorithms to generate the required leaf trajectories assume that the leaf positions are exactly known to the MLC controller. In practice, leaf positions are defined by a calibration procedure, which introduces an element of variability into those positions. The purpose of this study was to determine the effects of this variability on intensity modulated beams. METHODS: Dynamic leaf trajectories for surface-compensated fields were generated using in-house software. Variations in leaf calibration were simulated by adding or subtracting constant offsets to all the leaves in a single bank, or by multiplying leaf positions by the worst gains tolerated by the calibration procedure. Prescriptions incorporating these modifications were delivered to a phantom using an Elekta MLC. Film dosimetry was used to measure the resulting dose distributions, which were compared with the dose distribution from an unmodified field. The primary dose alone was also computer simulated. RESULTS: Two main effects were observed. Firstly, the field edge was shifted in proportion to the leaf offset. Secondly, within the field the doses were either increased or decreased by a similar amount over the whole beam, again related to the leaf calibration variation. Generally, the dose measurements gave slightly larger changes than the computer predictions. CONCLUSION: These errors warrant careful consideration of the treatment planning margins and the tightness of leaf position tolerances required for dynamic multileaf intensity modulation.

POSTER 1308

Effects of energy spectrum on the depth dose distributions for high energy electron beams

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INTRODUCTION: We have demonstrated the possibility of using Monte Carlo generated pencil beams for 3D electron beam dose calculations. However, in this model the electron beam is still considered monoenergetic and the effects of energy spectrum are taken into account by correction factors derived from measured central-axis depth dose curves. In the present model, the electron beam is considered polyenergetic and the pencil beam distribution of a clinical electron beam of given nominal energy is represented as a linear combination of Monte Carlo monoenergetic pencil beams. MATERIAL AND METHODS: The coefficients of the linear combination describe the energy spectrum of the clinical electron beam and are chosen to provide a best-fit between calculated and measured central axis depth dose in water. The energy spectrum is determined by constrained least square method. The angular distribution of the clinical electron beam is determined by in-air penumbra measurements. RESULTS: The predictions of this algorithm agree well with measurements in the region near the surface and the discrepancies between measured and calculated dose distributions, behind 3D heterogeneities, are reduced to < 10%. CONCLUSION: We have demonstrated a new algorithm for 3D electron beam dose calculations, which takes into account the energy spectra. Results indicate that the use of this algorithm lead to a better modelling of dose distributions downstream from complex heterogeneities.

POSTER 1309

Conformal therapy? Only if the machine maintains its parameters—"quality assurance regimes"

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With ever more pressure on departments to carry out more quality assurance (QA) on radiotherapy treatment machines, methods of streamlining standardising, and reproducibility are required. The onus of these checks is usually on the Physics Department, but the majority of basic machine QA can be carried out by any authorised person who has undergone some basic training and is given limits to which to work. The main stumbling block is that many tests which are repeated frequently take longer than they should and the results are often questionable, and not always repeatable. This is caused by two main reasons: (i) lack of clear protocols and guidance notes with tolerances; (ii) standardised test equipment, especially for basic mechanical checks. We have developed two main test tools which cover all the mechanical, light field, optical distance indicator (ODI), and patient set-up devices. This has enabled us to perform frequent QA tests using different types of personnel, whilst obtaining consistent results. There are also simple jigs, used daily by the operators to carry out a written protocol, which are of a common design to many centres. We have two levels of QA, the first is the operator who carries out a daily routine and safety checks that may be

required after a breakdown. Each of these checks that requires a physical measurement is given a tolerance greater than the Physics Standard. If any of these checks are out of specification, or a function of the machine is not correct, there are named persons who must be informed before treatments may commence. The second level of QA are tests of the definitive type carried out by the Physics/Engineering Department. There is no longer a need for graph paper, pens, rulers and sticky tape. The two main units have direct reading scales and simple levelling devices. Inserts for irregular shaped fields ≤ 10 cm and stereotactic work allows for customised QA per patient. The use of these units has actually reduced the time required for QA and has helped to encourage all staff to participate in this work.

POSTER 1310
Digital overlays as an aid to treatment verification using electronic portal images
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PURPOSE: The Lancashire and Lakeland Radiotherapy Unit is a newly established centre where the implementation of radiotherapy techniques has run in parallel with the commissioning of new equipment. This study investigates the possibility of more "elegant" methods of treatment verification using portal imaging. MATERIALS AND METHODS: Our equipment includes two Philips/Elekta SL 15 machines, one with electronic portal imaging (SRI-100) and multileaf collimation, a Philips multileaf preparation (MLP) system and a Nucletron Plato 3D treatment planning system (TPS). The MLP system can export leaf positions and anatomical marker points in a graphical form, suitable for import into the SRI-100 as a digital overlay superimposed automatically and instantaneously on newly acquired electronic portal images (EPIs). SRI-100 EPIs have been exported to the Plato TPS to investigate the use of more remote analysis of field placement error (FPE) with respect to CT planning information. RESULTS: On the SRI-100 the user can quickly verify the field shape and position of anatomy with respect to the digital overlay. FPE can be analysed for both intertreatment and intratreatment acquired EPIs, with respect to the simulator-derived "gold standard". On Plato analysis of FPE with respect to field edge, target volume and contours derived from bony anatomy are all possible. CONCLUSIONS: The use of digital overlays can provide helpful additional information for analysing FPE. That derived for instant overlay at the point of acquisition can be used for on-line decisions. Digital overlays on Plato enable CT derived "gold standards" to be used for FPE analysis in a retrospective fashion.

POSTER 1311
ShieldCalc: a spreadsheet for assessing radiation shielding in diagnostic imaging facilities
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Radiation shielding in diagnostic imaging facilities can be readily assessed using transmission measurements of isotopes, such as ^{192}Ir or ^{241}Am. This presentation describes ShieldCalc, a spreadsheet-based method developed at this institution for calculating equivalent lead thicknesses, using transmission measurements from a collimated isotope source. ShieldCalc can be run on either a PC or a laptop computer. Input data required are the reference unshielded count/dose rate at a reference distance from the source and a measured narrow-beam linear attenuation coefficient for lead. In operation, the user provides the spreadsheet with: the background dose rate; physical separation between source and detector with the shield in place; and measured count/dose rate. The spreadsheet calculates the equivalent thickness of lead of the absorber, with results presented in both tabular and graphical forms. Examples of the spreadsheet using ^{241}Am will be shown.

Radiation Protection

POSTER 1401
Withdrawn

POSTER 1402
An audit of patient entrance surface doses using a PC-based relational database
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A relational database was developed for use in the radiology department to determine patient entrance surface dose as an aid to the data management of a departmental quality assurance programme. This database was distributed to 12 hospitals in the Merseyside area and subsequently used to calculate entrance surface dose for PA chest and AP lumbar spine examinations, from a knowledge of the radiographic factors used and a calibration of the radiation output of the X-ray tube. This paper will present the results of these dose audits and indicate the distribution of entrance surface dose along with mean entrance surface dose per examination. This enables comparison of locally achievable dose levels with the guideline reference doses for these examinations published in the *National Protocol for Patient Dose Measurement in Diagnostic Radiology*. Also presented will be an intercomparison of the method of determining entrance surface dose (by calculation), with the method recommended in the National Protocol (TLD), which will show that calculation of entrance surface dose is a suitable method for performing patient dose measurement as part of an ongoing departmental quality-assurance programme.

POSTER 1403
Can an increase of 10 kVp and 20 cm focal film distance reduce the dose for certain spinal examination?
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PURPOSE: To compare two techniques of examining the lateral thoracic spine, in terms of diagnostic film quality, effective and skin dose to the patient. Also to compare the effective and skin dose to the patient for lumbar spine examinations when the kVp is increased to 95 for the lateral and 85 for the anteroposterior (AP) with a focal-film distance (FFD) of 120 cm. METHOD: Exposure factors and patient data (height and weight) were recorded. Radiographers alternated technique, ensuring approximately the same number of results for each technique and bias due to personal preference was minimized. The effective and skin doses were calculated by the medical physics department. To ensure the diagnostic quality of the films did not suffer, they were reported (and their quality assessed) by the same consultant and senior registrar who were unaware of which technique had been used. RESULTS: All films viewed within this study were deemed to be of acceptable diagnostic quality. The dose results are displayed in graphical form. Lumbar spine: a reduction of 57.14% in mean effective dose (MED) (mSv) and 60.11% in mean skin dose (MSD) (mGy) for the AP projection and a 51.42% reduction in MED (mSv) and 56.75% in MSD (mGy) for the lateral. Thoracic spine: a reduction of 90.09% MED (mSv) and 92.78% in MSD (mGy). CONCLUSIONS: By changing technique, as outlined above, a significant reduction in dose can be achieved. The departmental protocol has been altered to reflect these findings and an audit planned to ensure the MED and MSD remain as low as reasonably possible and that staff have altered their technique accordingly.

POSTER 1404
Dose–effect relationship and latency of radiomyelopathy—a reanalysis
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PURPOSE: Statistical reanalysis of experimental data on radiomyelopathy. MATERIALS AND METHODS: The cervical spinal cords of 276 rats were irradiated using conventional fractionation (30 single doses of 1.5–4.0 Gy each, total dose 45–120 Gy over 6 weeks) and hyperfractionation (60 single doses of 0.75–2.5 Gy each, total dose 45–150 Gy over 6 weeks, time interval between the daily fractions 11 h. The animals were killed when they presented paresis of the hind legs and the spinal cord was histologically examined. Data concerning dose effect relationship and latency were reanalysed statistically, using a multivariate logistic regression model. RESULTS: The dose–effect curves after conventionally fractionated and hyperfractionated radiotherapy were significantly different. The effective dose for 50% (ED_{50}) after conventional fractionation amounted to 73.4 Gy, after hyperfractionation it was 94.1 Gy, the difference being highly significant. The analysis of latency showed a strong dose and therapy schedule dependence. The shortest latency period was 5 months, regardless of dose. CONCLUSIONS: The tolerance dose after hyperfractionation was 28% higher than after conventional fractionation. α/β value was 1.54 Gy. Higher doses shortened the latency, but even after the highest doses, the minimum latency period was 5 months.

POSTER 1405
Mutations in DNA fingerprints of the children of atomic plant workers
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The aim of this investigation was the evaluation of germline mutation of mini-satellite DNA in children of PA "Mayak" atomic plant workers, exposed to chronic external γ-irradiation 40–45 years ago. DNA fingerprints were generated from blood obtained from 69 children and their 104 parents using biotin CAC_5 oligonucleotide probes. The first group evaluated included 50 children, whose parents had been exposed to doses of 100–756 cGy to the gonads. The second group included 19 children, whose parents had been exposed to doses of 1–96 cGy. DNA was digested with the restriction endonucleases Hinf1 and Bsu RI and DNA bands were fractioned on 0.7% horizontal agarose gels in TAE buffer for up to 48 h at 1 V cm^{-1} with vacuum blotting on nylon membranes. Probe labelling and hybridization in the membrane was with conjugated streptovidine with alkaline phosphatase. The frequency of mutations was determined by relating the mutated DNA band to all DNA bands in groups on the gametes. The frequency of mutation in the first group was 0.0017/band/gamete. In the second group this frequency was lower—0.0011/band/gamete. This difference was not significant (Fischer's exact test = 1.25, $p > 0.05$). The frequency in the second group was identical with that in the total population, determined by the same method. The results obtained in this investigation agree well with data obtained from Japanese atomic bomb survivors (M Kodaira et al, 1995) and do not agree with data obtained from the Chernobyl accident population (Y E Dubrova et al, 1996).

POSTER 1406
Do current radon action levels reflect the dose received by occupants?
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In the UK action levels for radon are 400 Bq m^{-3} in the workplace and 200 Bq m^{-3} for the home. Hourly measurements have been taken in a number of locations with raised radon levels in Northamptonshire. Dose to occupants has been assessed using a questionnaire to find the length of time spent at the location. These doses have been compared with the average radon level. In the workplace, results for 67 staff suggest that doses are lower than expected, due to part-time working and the mobility of staff. It is suggested that an action level of 800 Bq m^{-3} might be more appropriate. In a limited survey of domestic premises, we have found several cases of almost total occupancy—specifically Asian wives in purdah—where doses exceed that expected. When radon levels are reduced in the workplace, in a pilot study of five locations, we have found that the dose to the occupants drops by only half of the drop in average radon levels. This suggests that a new action level for the remediated workplace should be established at half the normal workplace action level.

Radiotherapy

POSTER 1501
Radiotherapy of malignant paragangliomas of the carotid body and the glomus jugulare
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BACKGROUND: Paragangliomas are rare neuroendocrine tumours of the head and neck. Most of them are benign tumours which grow slowly; the criterion of malignancy is not based on the histological picture, but on the presence of metastases. MATERIALS AND METHODS: Between 1986 and 1994, seven patients (one male, six female) with malignant paragangliomas of the carotid body ($n=5$) and the glomus jugulare ($n=2$) received megavoltage radiotherapy either alone ($n=2$) or after incomplete surgery ($n=5$). In three patients a preoperative embolization of the supplying arteries was performed. A total dose of 46–56 Gy, 1.8–2 Gy/5 days a week, was delivered either by angled anterior and posterior oblique, wedged fields or parallel opposed fields. RESULTS: Long term control—including two salvage procedures—was obtained in six patients, with a follow-up of 35–125 months (mean 93 months), five of these patients demonstrated a stable residual mass on CT scans, but a symptomatic relief was noted in all patients. No serious acute or late radiation-induced complications were observed. One patient died of the disease; after macroscopically-incomplete resection of an advanced tumour of the carotid body, postoperative radiotherapy was cancelled by this patient after 4 Gy. 10 months later she presented with a massive tumour progression, invasion into the brain and exulceration of cervical lymph nodes, and was irradiated with 56 Gy. She died as a result of distant metastases after 26 months. CONCLUSION: Megavoltage radiotherapy is a safe and effective treatment in patients with malignant paragangliomas of the glomus jugulare and carotid body. Stabilization or reduction in tumour size after radiotherapy are indicative of local control.

POSTER 1502
A pilot study of the use of teletherapy in the treatment of age-related macular degeneration
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There are 1 million visually handicapped people in this country. 50% of all registered blind suffer from age-related macular degeneration (AMD). Prognosis of untreated AMD with choroidal neovascularization is poor and the patient may lose vision rapidly. A number of centres have investigated the use of low dose radiation to the macular region to maintain central vision and induce regression of subfoveal neovascular membranes which are not considered amenable to laser treatment. The published reports indicate a varying but moderate degree of success. This paper discusses the methods and materials used for radiation treatment planning and dose delivery with an indication of preliminary results. METHODS AND MATERIALS: Low dose radiotherapy of the macular region has been carried out on 23 patients since May 1995 using a 10 MV X-ray beam. A beam direction shell is used for patient immobilization during radiotherapy treatment. A single radiation beam of 3×2 cm angled 10° posteriorly to miss the contralateral eye is used for treatment. The dose is prescribed to the 90% contour measuring 1.4 cm across in AP plane. 10–15% of the given dose is received by posterior part of the lens. The contralateral eye receives 2% of the given dose. Seven patients had a dose of 10 Gy/5 F, three of 12 Gy/6 F, and 13 of 20 Gy/5 F. In all patients the entire course was delivered in 8 or less days. RESULTS: The results obtained to date appear less favourable than those previously reported. Only a small proportion of the patients have retained useful central vision. The possible reasons for this will be discussed.

POSTER 1503
The use of non-metallic deodorant during radiotherapy treatment
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PURPOSE: To assess skin reactions in patients using a non-metallic deodorant during radiotherapy treatment to the breast. To ascertain whether the use of deodorant affects a patients' psychological

well-being. MATERIALS AND METHODS: 78 patients were selected and asked to enter the trial. 35 patients consented and were randomized into one of two groups. One group received the standard skin care instructions and leaflet, whilst the other group were also given the deodorant. All patients were seen routinely on a weekly basis and were assessed for any skin reaction which was scored and recorded. A questionnaire was completed during the last week of treatment. RESULTS: No statistically significant skin reactions were seen in patients using the deodorant. However, the only reactions noted in the axilla were in patients using the deodorant. Patient's well-being and comments were expressed. CONCLUSION: The use of this non-metallic deodorant did not produce any significant difference in skin reactions. However, a larger study may ascertain whether the increased axillary reactions are due to the deodorant or perhaps the form it is in. More patients preferred to use deodorant than not, although comments were made about it being in a stick form.

Skill Mix

POSTER 1601
Role extension and barium enemas: a radiographer's perspective

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In many areas of radiology, radiographers have proved able to operate effectively with training, one such area being barium enemas. So just how effectively are we operating? The purpose of this ongoing study is to evaluate the accuracy and value of preliminary reports provided by the radiographer, prior to the official reporting by the radiologist. Accuracy will be discussed in terms of sensitivity and specificity. Evaluation of the impact this service is having will be made and the experiences that the radiographer will encounter will be discussed. The study was initiated in March 1997 after completion of the barium enema course at St James's University Hospital, Leeds. Preliminary reports are provided, alongside the images to assist the radiologist in their diagnosis. Audit has been essential to ensure that a high level of clinical knowledge and competency has been achieved and is being maintained. A comparison of radiographer and radiologist reports has been made. In the case of conflicting diagnoses, films have been recalled and rereported by another radiologist and, in some cases, a clinical follow-up has been necessary. The sample size is, as yet, undetermined. A post-certification month-to-month level of competency comparison is being made to assess if accuracy levels are improving with experience. Preliminary findings have been encouraging, with an overall sensitivity of 96% and a specificity of 87% being achieved. Data collection will end in April 1998 and, so far, the general trend shows that these figures will improve.

POSTER 1602
The reporting performance of radiographers, student radiographers and a neural network

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PURPOSE: Experiments were carried out to determine the diagnostic performance of undergraduate radiography students and postgraduate radiographers on a role development programme in image reporting. A back propagation perception neural network was also compared with radiologists. METHODS AND MATERIALS: 19 undergraduates and eight postgraduate radiographers were tested in the detection of Colles fractures in 210 wrist images. The digitized test images contained normals and fractures Graded 1, 2 and 3 verified from radiology reports. The test banks were scrutinized by the neural net after an initial training program using 550 similar images. RESULTS: ROC analysis was applied to the data from the human observers and the neural network. Direct performance evaluation was determined from the areas under the ROC curves. A filter analysis was applied to the human data using the neural net output to demonstrate the impact of machine preview of a simple radiographic reporting task. CONCLUSION: Back projection neural networks can enhance the specificity of some radiographic reporting tasks.

POSTER 1603
Review of outreach US recall requests April–December 1996 Windhill Green Medical Centre

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PURPOSE: To assess the efficiency of the service based on criteria of number of patients requiring follow-up examinations at hospital base. METHOD: A retrospective study of all patients attending in a 9 month period for examinations in three key areas, abdominal, renal and pelvis. 1012 patients were scanned during the study period (fundholding and non-fundholding), using Ultramark 4 machine with 3.5 mHz and 5 mHz transducers. RESULTS: Follow-up was suggested in 120 cases, only 58 had subsequent examinations. *Abdomen*: 16 patients of 345 had follow-up scans or other investigations. Four had scans due to clinical concern, one was technically difficult. 12 had other investigations—one biopsy, six CT, two ERCP, Ba enema, two chest radiograph. *Renal*: Nine patients of 145 had follow-up scans. Two had scans, both patients require further review or CT, two KUB X-ray, four IVU, one CT. *Pelvis*: 33 patients of 515 had follow-up scans. The four main reasons for recall were: different stage of subsequent menstrual cycle; clinical; technical; radiologist's suggestion. In the first category cysts identified resolved in all cases. 15 patients attended for clinical reasons. In all cases transvaginal (TV) scan confirmed transabdominal result. Of these patients, seven had no further action, eight needed review or gynaecological referral. Nine patients were scanned under technical category. TV scan clarified and confirmed results. No patients were re-scanned. CONCLUSION: 94% of patients did not require further investigations after initial scan. There are no comparative results for patients scanned within the hospital.

Urogenital

POSTER 1701
An evaluation of fluid restriction in iv urography using non-ionic water soluble contrast media

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PURPOSE: Historically, patient preparation for iv urography (IVU) involved dehydration. By the 1980s this was deemed unnecessary on the basis of work using ionic water soluble contrast media. However, non-ionic contrast media is now universally used for IVUs in the UK and there is currently no evidence to confirm or refute any advantages gained in this context by patient fluid restriction. Fluid restriction, (no fluid from 2200 h the night before) is standard practice in our department in the preparation of patients for iv urography. This study was to evaluate any benefit that this practice conferred. METHOD: 400 patients were randomly assigned to one of two groups, one whose fluids were restricted and a second group who were given no specific instructions regarding fluid intake. All iv urograms were performed using the same technique and contrast (Iopamidol 370) and reported by a consultant uroradiologist who, blinded to the patient preparation, made an assessment of the quality of renal tract opacification. The nephrogram, pelvicayceal system, ureters and bladder were scored separately, the emphasis being placed on the first two. RESULTS: The urogram scores for each group were evaluated using non-parametric analysis (repeated analysis of variance) and there was no significant difference between the groups, p values for the nephrograms and pyelograms being 0.9 and 0.37, respectively. CONCLUSION: Fluid restriction does not improve renal tract opacification when using non-ionic water soluble contrast media.

POSTER 1702
Assessment of renal volumes using spiral CT: validation of a low dose protocol using a porcine model

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PURPOSE: Renal size is an important parameter in the assessment of renal disease. Renal lengths determined using US have become a widely used clinical tool. However, they may not reflect true renal size, due to errors in length measurements and the variations in renal morphology. Spiral CT allows direct measurement of renal volume but, using conventional methods, the radiation dose delivered is high. We set out to develop and test a CT protocol enabling renal volume assessment at the lowest possible radiation dose. MATERIALS AND METHODS: Sections of porcine abdomen with the kidneys *in situ* were scanned on a Toshiba GX Spiral CT

scanner. Multiple parameters were used to determine the minimal exposure which allowed adequate discrimination of kidneys from surrounding fat. The minimally acceptable parameters were 120 KV, 50 MAS/rotation, 3 mm collimation, pitch of five, index of 3 mm. The cross-sectional area of the kidneys was measured by drawing regions of interest on each slice and the volume was calculated. These measurements and calculations were repeated to take account of intra-observer error. The kidneys were then dissected out and their actual volumes measured by displacement. Radiation dose was estimated using the Monte Carlo programme provided by the NRPB. RESULTS: The calculated volumes were within 4–8% of the actual volume. The estimated effective dose was 0.5 mSv. CONCLUSIONS: In this animal model, spiral CT measured renal volumes accurately at low radiation dose. Further evaluation in humans is required, but this technique offers considerable potential in the assessment of renal volumes.

POSTER 1703

Three cases of renal malacoplakia: an important consideration in the differential diagnosis of renal masses

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Malacoplakia is an uncommon, inflammatory, multi-system disorder which usually affects the genitourinary (GU) tract and is frequently associated with *E. Coli* urinary tract infections (UTI). Of the 200 cases recorded in the literature, 75% affected the GU tract and only 15% of these affected the kidney. Renal involvement is usually unilateral and multifocal, but unifocal changes occur in 25% of cases and simulate renal tumours. We describe three cases of elderly female patients, with variable clinical presentations, all of whom had recurrent, documented *E. Coli* UTI. These led to investigation with renal tract US in all three cases. One patient had an enlarged kidney with abnormal echo-texture, whilst the other two cases had focal renal masses. One of these simulated a renal abscess, which was drained. A subsequent CT examination and image-guided biopsies showed changes of malacoplakia. The appearances of malacoplakia within the kidney are non-specific and may simulate renal cell carcinoma and abscesses, as our pictorial review illustrates. In terms of prognostic assessment and treatment planning, a biopsy diagnosis is desirable and should be considered in the differential diagnosis of focal renal masses and multifocal renal abnormalities, particularly in the presence of *E. Coli* UTI. The treatment of choice is nephrectomy but, in patients unfit for surgery, long-term treatment with quinolone antibiotics is the conservative option. The apparent cluster of cases of this rare condition demonstrated here may be due to the increased use of cross-sectional imaging and biopsy in the investigation of elderly, hospitalized patients. It should be considered in the differential diagnosis of a renal mass, particularly in patients with *E. Coli* UTI.

POSTER 1704

The relevance of parity to ureteric dilatation

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PURPOSE: To assess whether mild dilatation of the right ureter in female patients, not infrequently seen at iv urography (IVU), represents persistent dilatation following pregnancy. METHODS: IVUs of 71 males, 63 parous and 27 nulliparous females were prospectively evaluated. The two female populations were divided into patients with and without a proven history of urinary tract infection (UTI), producing five groups in total. Measurements were taken on both the 5 min and either the compressed or release films on each side. RESULTS: There were no significant differences in ureteric measurements between the five groups for the uncompressed right ureter ($p=0.23$), left ureter uncompressed ($p=0.32$), or compressed ($p=0.87$). For the compressed right ureter, the difference was significant, with the measurements in the parous females with proven UTI being larger than the other groups ($p=0.43$). CONCLUSION: There is a significant increase in the diameter of the compressed right ureter in the group of parous females with a history of proven UTI. Infection or parity alone do not produce this effect, the combination of the two factors is required.

POSTER 1705

Comparison of 2D thin section and 3D MRI for prostate cancer staging

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INTRODUCTION: MRI has been used increasingly for the staging of prostate cancer. This study compares the clinical utility of 3D fast spin-echo (FSE) and 2D thin section FSE sequences to improve the staging accuracy of MRI in prostate cancer. MATERIAL AND METHODS: 17 patients (mean age 62 years) with TRUS biopsy-proven prostate cancer were investigated on a 1.5 T GE Signa System. Imaging was performed using a combination of a pelvic phased array and endorectal surface coils. Two series of images were acquired in the axial plane: a 3D FSE sequence (TE/TR = 132/3800 ms) and a 2D thin section FSE sequence (TE/TR = 130/12600 ms). Both sequences were acquired with a 16 cm field-of-view and a 2 mm slice thickness. These sequences were subsequently compared, both in the original acquisition plane and in reformatted orientations, for their ability to detect and stage tumour. Images were viewed on a GE Advantage Windows system by two independent observers blinded to each other's results. RESULTS: Signal-to-noise and contrast was generally poorer using the 3D sequence. However, both reformatted sequences provided valuable information concerning tumour volume/capsular penetration, with alteration in tumour staging demonstrated in 31 and 35% of cases by the two observers respectively. CONCLUSIONS: The 3D FSE sequence offered no routine advantage over the conventional 2D FSE acquisition. However, the ability to reformat and visualize images in arbitrary orientations provided clinically important information in a third of cases.

POSTER 1706

Quantitative dynamic contrast enhanced MRI in the prostate following radiation therapy: preliminary results

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PURPOSE: To examine and quantify changes in the prostate gland following the treatment of prostatic carcinoma by radiation therapy. MATERIALS AND METHODS: Dynamic contrast enhanced imaging was performed on eight patients both prior to and following radiation therapy for prostatic carcinoma. The mean time between these scans was 13.8 months. All imaging was performed on a 1.5 T GE Signa using combined endorectal and pelvic phased array coils. Initial localizing images were followed by acquisition of a series of axial T_2 weighted FSE images. These images were used to select four slices (7 mm thick with 2 m intersection gap) for investigation with dynamic contrast enhancement. This involved collecting a series of proton density-weighted images using a FSPGR sequence (TR/TE/flip = 120/2.9 ms/8°) prior to a series of T_1 weighted FSPGR images (TR/TE/flip = 10.4/2.9 ms/25°) acquired in a dynamic fashion. In total, 35 time points, each having a temporal resolution of 11 s, were collected with a bolus of 0.1 mmol Kg^{-1} Gd-DTPA administered after the third time point. Parameter maps of the prostate were produced on a pixel-by-pixel basis for values of enhancement factor (EF) at each time point, maximum EF and time-to-maximum. RESULTS: In five patients regions demonstrating contrast uptake were reduced in both size and magnitude following radiotherapy and values of time-to-maximum became significantly longer. These changes correlated with a significant reduction in PSA level. CONCLUSIONS: The results demonstrate intraprostatic vascular changes following radiotherapy. The methods described improve the visualization of the effects of radiotherapy and allow these changes to be quantified.

POSTER 1707

The quantification of the apparent diffusion coefficient (ADC) in normal and malignant tissue in the prostate

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PURPOSE: The quantification of the apparent diffusion coefficient (ADC) in normal and malignant tissue in the prostate using MRI. MATERIALS AND METHODS: Five normal volunteers and two patients with tumours were scanned using diffusion weighted (DW) echo planar imaging (EPI) at 1.5 T. ADC values were calculated by fitting a single exponential decay curve to six DW echo planar images with b factor values in the range 0–740 s mm^{-2}. In-plane resolution and slice thickness were 1.67 and 7 mm respectively. RESULTS: ADC values were sampled in regions of interest (ROIs) (size 3×3 pixels) drawn in the peripheral zone (PZ) and central gland (CG) in the seven subjects. In all five volunteers, the ADC values were higher in the PZ (mean $\pm$ sd $= 2.32 \pm 0.66$ mm s^{-2}) than in the CG (1.69 ± 0.36). Initial results on two patients indicate that areas in the PZ occupied by malignancy show significant decrease in the ADC values. Further data sets are being acquired. CONCLUSIONS: DW MRI allows non-invasive quantitative measurement of the ADC in the prostate. Initial results indicate higher values for the apparent diffusion coefficient in the PZ than in the CG and significant reduction in PZ areas occupied by malignancy, indicating reduced liquid mobility.

POSTER 1708

A simple method for the correction of endorectal surface coil inhomogeneity in prostate MRI

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PURPOSE: Prostate MRI is commonly performed using endorectal surface coils. While these coils offer superior signal-to-noise, they also introduce marked signal variation due to their inhomogeneous reception profile. A method is described which corrects for the resulting image inhomogeneity. MATERIALS AND METHODS: All studies were performed using a 1.5 T GE Signa using combined pelvic phased array and endorectal coils. As part of an on-going study, patients with newly diagnosed prostate carcinoma were examined. Initial localizing images were followed by a series of axial T_2 weighted FSE images (TR/TE = 3640/153 ms) acquired from the prostatic apex to seminal vesicles. Each image was 4 mm thick with a 1 mm intersection gap. Subsequently, a series of proton density-weighted images were acquired at the same locations and with the same thickness using a FSPGR sequence (TR/TE/flip = 300/4.2 ms/8°) in order to demonstrate the coil sensitivity profile *in situ*. These images were then used to create a pixel-by-pixel matrix of scaling factors for each slice, using the ratio of each pixel intensity to the maximum value in the image. This matrix was then used to correct corresponding pixel intensities in the T_2 weighted data set. RESULTS: The coil "flare" is successfully removed, leading to simultaneous visualization of all intraglandular structures without resorting to time-consuming image windowing. CONCLUSIONS: The method is simple to implement and effectively corrects for the B_1 inhomogeneity, resulting in improved image quality.

POSTER 1709

Morbidity of prostate biopsy—the impact of additional seminal vesicle biopsies or aspirin ingestion

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PURPOSE: To determine the effect of additional seminal vesicle biopsy and incidental long-term aspirin ingestion, on the morbidity of US-guided prostate biopsy. METHODS: The morbidity of transrectal US-guided prostate biopsy was studied prospectively in 187 patients who filled in a questionnaire regarding symptoms for a week after biopsy. These included pain, fever, haematuria, PR bleeding and haematospermia. They were also asked if they needed to see their GP, or if they were on long-term aspirin therapy. RESULTS: 89 patients had standard sextant biopsies, 98 had additional bilateral seminal vesicle biopsies and 50 patients were incidentally taking aspirin. All had antibiotic prophylaxis. Results will be presented with statistical analysis. The overall morbidity was as follows: haematuria 62%, pain 28% (with only 10% requiring simple analgesics), haematospermia 26%, PR bleeding 23%, fever 10% (median length for all these was 2–3 days). Only 11 patients saw their GP subsequently—with four requiring a further course of antibiotics and none needing hospitalization. Aspirin ingestion had no significant effect on morbidity. Additional seminal vesicle biopsy appears to slightly increase the risk of haematospermia and PR bleeding. CONCLUSION: This prospective study confirms the low incidence of serious complications after US-guided prostate biopsy. Bleeding (urine, PR and ejaculate) are to be expected, but are self-limiting. Aspirin does not appear to affect morbidity. Additional seminal vesicle biopsy appears to slightly increase the risk of haematospermia or PR bleeding.

POSTER 1710

Evaluation of US contrast in focal prostate lesions

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PURPOSE: Evaluation of BR1 (Bracco, Milan, Italy) in characterization of focal prostate lesions. MATERIALS AND METHODS: 17 patients (age range 57–81) enrolled in the study attending for TRUS prostate biopsy were given two iv injections each (a total of 34 injections) of BR1. All patients had a focal greyscale abnormality. Greyscale (GS) and colour Doppler energy (CDE) were recorded at baseline in all patients and continuous S-VHS recordings were obtained during contrast enhancement. To avoid contrast doses accumulating, injections were separated by at least 10 min. The focal parenchymal lesions were targeted at biopsy and random prostate biopsies were also taken. Pathological confirmation of random and target lesions were obtained in all cases. RESULTS: A total of 10 adenocarcinomas were found in 17 patients: target biopsy was diagnostic in 6/10 and random biopsy revealed a further four foci of adenocarcinoma. The remaining focal lesions constituted hyperplasia, atrophy, prostatitis or combinations of these. Of the 17 target lesions, 15 were available for additional analysis. Lesions were characterized as to whether there were focal vessels within or around the lesion. The location and degree of enhancement of these vessels was evaluated using a combination of the baseline and the maximum enhanced post-contrast study. Five lesions with a vascular pattern predominantly around the focal area, displayed hyperplasia, atrophy or prostatitis. 10 lesions with vascularity within the focal area revealed adenocarcinoma in five and hyperplasia or prostatitis in five. CONCLUSION: The presence of a baseline and/or enhanced vascular pattern within a focal prostate greyscale lesion may be a useful additional indicator of the presence of malignancy. This does not obviate the need for other targeted biopsies or sextant biopsy. Further work, with a larger series of patients, needs to be undertaken.

POSTER 1711

Can transvaginal Doppler US diagnose pelvic congestion? A comparison with transuterine venography

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PURPOSE: Pelvic pain is the commonest condition for which a gynaecologist is consulted. Many of these women who consult a gynaecologist have pelvic venous congestion, which is currently diagnosed by venous diameter and contrast clearance from the pelvis during transuterine venography (TUV), an invasive, uncomfortable procedure, requiring sedation and irradiation of the pelvis of women in their child-bearing years. This study has investigated transvaginal US (TVUS) as an alternative diagnostic modality. MATERIALS AND METHODS: 41 women attending for TUV also underwent TVUS during the same session. Uterine and ovarian morphology were noted and para-ovarian/para-uterine veins identified and interrogated using grey-scale, Doppler and power Doppler US. Findings were recorded and a congestion score conferred according to a pre-determined scale. TUV was then performed. Under sedation, 20 ml water-soluble contrast was injected into the fundal myometrium and spot-films taken at 0, 20 and 40 s. Congestion was scored according to published criteria by a second observer, blinded to the TVUS score; scores from TVUS and TUV were compared. RESULTS: 41 women have been studied to date, median age 29 years, range 22–59. There was positive correlation between TVUS congestion scores (median score 5, range 3–9) and those from TUV (median score 6, range 3–9), Pearson coefficient 0.37, $p = 0.017$. However, there was a significant tendency for TVUS to underscore, compared with TUV ($p = 0.026$). CONCLUSION: TVUS is generally able to discriminate between women suffering from congestion and those who do not, but considerable individual variability may limit its application for initial diagnosis. Additional benefits conferred by Doppler and power Doppler measurements will be discussed.

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A Web-based review and teaching tool using server-side DICOM translation

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A review system has been constructed using Microsoft's Internet Information Server with ActiveX, ISAPI and Active Server Pages extensions which allows medical images to be viewed using a standard Web browser. Images are converted on request from DICOM part 10 storage format via a PACS server with patient demographics available directly from the PACS database. The PACS database is extended to include additional information such as teaching information, preferred display parameters and access permissions. Problems of low network bandwidth are catered for by converting the large medical format images into the compact JPEG standard format. Multi-frame dynamic modalities such as cardiac angiography studies are made available by storing them as multimedia standard "movie" files alongside the DICOM data. Modality-specific image display issues (*e.g.* windowing of a CT image), are dealt with by server-side programs. Updates to the image display can be made following re-specification of the display parameters within the Web document. Access to medical data can be controlled down to patient level and beyond by taking advantage of Windows NT security features within the browser. The system is a step towards a secure electronic patient record, accessible network-wide, which brings together in a single document all relevant patient data, including image studies from different modalities. Viewing applications require only standard Web browsers since image display and secure identification are handled by the Server. Immediate applications include a teaching database and review of digital images on the ward or in theatre.

A Web-based radiology MCQ tutor: a novel assessment based educational aid

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A fast, user-streamed, personalized MCQ teaching aid which is Web-based and widely resource-linked is presented (http://www.MCQs.com). We propose that this program, which is also reproducible on CD-ROM, has several advantages over traditional paper-based MCQs in the preparation for examinations and the continuity of radiological education. Randomly accessible sets of radiology questions of the Fellowship "true or false" type with negative marking and an optional timer mechanism were created and categorized according to specialty. The users are directed into banks of questions of varying difficulty in response to their previous grades; this inbuilt handicap system allows customized tuition based on the level of expertise of the user. Material for the questions is derived from standard textbooks and the additional novel resource of major journals that have recently become available online. Answers in the form of the "window.open" function include references to these online journals and personalized tutorials using text, multimedia and image-maps. Javascript allows an immediate answer in the form of an Alert dialog box integrated within the client's HyperText Markup Language (HTML) code and the final grade is calculated immediately within the client's browser. This replaces the cumbersome server based marking system traditionally used in most Web-based teaching sites. Feedback from the server enables continual revision of the bank of questions. This tutor thus represents an innovative and continuously updated radiology teaching aid that optimizes interactivity between the user and the tutor.

Stand-alone radiotherapy appointment booking system

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Radiotherapy appointment booking systems have recently become very complex, powerful and difficult to master. Most tend to be rather inflexible, merely booking a series of "slots" for all a patient's treatments, regardless of ward rounds, clinics or patient preference. It was felt by the author that patients, doctors and radiographers would benefit from a simple and flexible system that did not rely on "slots". This application uses data such as ward round days, reaction clinic days and outpatient preferences to divide the patients into groups, then sorts the patients within that group. A list of patient appointment times for the treatment unit is generated 2 or 3 days in advance to allow times to be given to patients for the next day. The radiographers can easily edit the new list, swapping times if necessary or making provisional bookings for new patients attending in the future. The application is customized for a particular machine (*e.g.* marking out clinics, calibration times etc.) and is also used for several other clerical duties by radiographers. Patient statistics are produced for the treatment unit and automatically stored in a database or printed out. Radiographers can also print out day case lists (outpatient attendance) and a list of patients whose notes will be needed in the following day's consultant clinic. The application is easy to use and does not need any connections, expensive hardware or a network to run on, requiring only a simple stand-alone PC on the treatment unit.

ROSS: Radiation Oncology Supporting Software of Samsung Medical Center

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We have developed the software "ROSS" (Radiation Oncology Supporting Software), a Delphi-based clinical work, documentation and training software program. ROSS is divided into three modules: Clinics, Documentation and Education. The aim of the Clinics module is to support the physics work for radiation therapy. Its main function is to calibrate the absorbed dose using the IAEA protocol, to calculate the monitor unit, including artificial intelligence, and to decide the room shielding design necessary for radiation protection. The room shielding program can display the treatment room three-dimensionally and calculate the absorbed dose outside the room including the door, using mouse interface. The Documentation module introduces our department—staff, facilities and activities—and a variety of useful information about the field of radiation oncology, using Internet connection. The Education module aims to train clinicians, physicists and technologists in radiation physics. The Education module is designed to teach by using interactive techniques and multimedia, such as video, audio and animation. Our experience with this system has demonstrated an improvement in the quality of radiation therapy.

Development of a system for the automatic scoring of TORMAM Images

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The TORMAM phantom is now widely used, as part of quality assurance programmes, in the assessment of image quality in X-ray mammography. Conventionally, images of the test object are assessed by human observers by assigning scores to features within the test object, depending on how clearly the features are judged to be represented in the image. This method of scoring leads to very large interobserver, and considerable intraobserver variation in the scores obtained. In order to reduce this variability, a machine-based scoring system has been developed. The exhibit describes the development of a software-based system for the machine scoring of TORMAM images. During the development of the system, digital images obtained using a low cost digital camera have been

employed, the system should, however, be capable of scoring images from a variety of input devices. The scoring system, which has been produced using the MATLAB development environment, attempts to mimick the human observer by assessing how well each feature in the test object is represented in the image. The techniques employed to implement the machine scoring system will be shown and the results of early trials presented. The scoring system will be available for demonstration.

Real-time attenuation-corrected Ultrasound imaging in obstetrics

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We have previously demonstrated the effectiveness of a new general method for correcting for attenuation applied to single ultrasonic B-scan images. This method, termed attenuation compensated imaging (ACI), calculates a unique attenuation correction function for each A-line in the image. The purpose of the present study was two-fold. Firstly to explore clinical value of ACI in obstetric ultrasound imaging. In these scans the ultrasonic attenuation varies strongly throughout the image but the consequent shadowing and enhancement cased by conventional time gain compensation (TGC) are not of diagnostic use. The second purpose was to evaluate ACI in real-time scanning. The ACI algorithm has been implemented on a multimedia computer with video interfacing and processing. Video sequences of ultrasound scans have been digitized and processed off-line. It was shown that the stability of the algorithm extends to cover dynamic frame sequences: the two parameters controlling the ACI process, once set, remain valid throughout a scanning sequence. The process has been shown to significantly improve the visualization of the fetal heart and thoracic contents when they would have been obscured by shadows from overlying fetal skeletal structures with conventional TGC. Other potential applications have been demonstrated in fetal pelvic scanning in the presence of pelvic or spinal shadows, for intracranial anatomy and when scanning a deeply lying placenta. Possible imaging artifacts generated by the algorithm appear to be very minor.

An interactive radiology teaching facility for skeletal trauma

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Postgraduate curriculum development in the Department of Radiography at the University of Salford has identified a need for innovative and flexible modes of course delivery. Work is in progress to provide an interactive multimedia teaching package to support the existing methods used in a program designed to develop knowledge and skills in the image interpretation and diagnosis of skeletal trauma. The package will contain a wide range of normal, normal variant and abnormal cases of the musculoskeletal system. The format will mimic the clinical environment so that each case will be presented with a clinical history and subsequent diagnosis. Images can be manipulated to give optimum viewing conditions, and previous cases can be viewed alongside the current examination to assist comparison. The initial stages of this work involve the development of a Web site which will allow anyone on the Internet access to the database. The system used is based on the industry standard Dicom 3, and can be linked to clinical departments via an ISDN line, enabling data to be both transmitted and received. A video conferencing link will allow interactive tutorials to take place which will reduce the amount of time students spend in college. The package will be copied to CD-ROM, facilitating access to a large, comprehensive teaching file. Students can then pursue their individual learning needs giving them greater flexibility of study. Although this is an exciting development in new methods of teaching and learning, it is intended that its implementation will complement rather than replace traditional techniques.

BJR Online

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Since January 1997, the *British Journal of Radiology* has been published on the World Wide Web as *BJR Online*. This service is available free of charge to BIR members and BJR library subscribers. Sample issues are also available via the BIR's Web site http://www.bir.org.uk. Advantages over the print version include: (a) more rapid publication; (b) links from the papers to the Medline abstracts of articles cited in their reference lists; (c) a search facility. This exhibit will offer delegates an opportunity to use *BJR Online*. We will also be pleased to answer questions about its availability, our access control methods and the registration process. We will be keen to receive delegates' feedback to assist our future development of *BJR Online*. We would also like to meet BJR authors to explore the possibility of enhancing their work by adding hotlinks from their articles, *e.g.* to their Web sites or to multimedia presentations.

Multimedia information system about a diagnostic imaging department

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Radiology directorates are constantly being asked to provide general information about their service to a range of interested people. Interested people could include school children, patients and potential healthcare students who wish to gain an insight into the discipline which they may eventually study. This multimedia prototype was developed to meet the needs of this diverse group. The prototype was developed in Toolbook II and runs on a Pentium 100 under Windows 95. The navigation system is based on a "building metaphor". Information about the main departments of the radiology directorate are accessed through "doors" leading from the "virtual hospital corridor". Each department has a consistent screen layout and the "exit" is again through a "doorway". General information about each department typically includes details about what it can be used for (by narrated video), the imaging equipment used (text and diagram) and other related information. The prototype, which is still under development, was created by two student programmers and academic and clinical staff with a knowledge of diagnostic imaging. Early usability analysis indicates it is intuitive, particularly since formative evaluation has suggested young children and adults almost immediately know how to use the navigation and media tools. After prototype completion, in the first instance, it is intended to install the information system into a local school and study children using it during project work. In addition, the information system will be installed on a server at a local university where prospective students can gain an insight into an example of a placement at which they may train.

Computer based information system for pregnant patients and members of the public

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Departments of [1]Radiography and [2]Midwifery, University of Salford, [3]Radiology Directorate, Hope Hospital, Salford, [4]Midwifery Directorate, Salford Royal Hospitals NHS Trust, Salford, UK

During pregnancy women and their partners require information about the choices available to them and what to expect throughout the various stages of pregnancy. Articulating information to patients is re-enforced through government papers such as *Working for Patients*, *The Patients' Charter and You: A Charter for England* and *The Changing Childbirth Document*. Pressure groups such as the National Childbirth Trust and professional bodies (for example, the Royal College of Midwives) support these views and urge health professionals to offer suitable information so that informed choices can be made in pregnancy. This multimedia presentation illustrates an information system for pregnant women, their partners and other "interested" members of the public. Initially the system was developed for obstetric ultrasound by approximately 60 patients and 20 healthcare professionals. Subsequently, led by midwives, the prototype has been extended to include significantly more detail about informed choice, this includes detailed information about "where to have your baby" and "what choices are available to you in pregnancy". The ultrasound prototype has been in clinical use for approximate 5 months and the enlarged "Choices in Childbirth" prototype will be implemented after debugging. Field trials on the Choices in Childbirth prototype will commence early in 1998. The information system, comprising text, narration, pictures, diagrams and video, is authored in Toolbook 4.0 and runs on a Pentium 100 under Windows 95.

Teleultrasound

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A live ISDN (Integrated Systems Data Networking) link will be set up between the radiology exhibit and St Richard's Hospital, Chichester; with the link extended to Cosham and Havant Health

Centres. The aim of "link-up" is to demonstrate the benefit of remote site training in ultrasound for radiographers, midwives and clinicians, along with the provision of a diagnostic referral service by consultants and specialists based in hospitals. The Congress delegates will be able to view the transfer of dynamic and stored ultrasound images with white-board tutorials. Delegates will also be able to observe, and participate in a live interaction.

Novel film viewing technology and EC '96 radiology quality guidelines

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The new *European Guidelines on Quality Criteria for Diagnostic Radiographic Images* (EUR #16260) and diagnostic paediatrics (EUR #16261) set new milestones in quality radiography in general, and in film reading device requirements in particular. This scientific presentation reviews the psychophysical basis behind those standards and demonstrates a new device the Digital Film Viewer® system (DFV) which fully complies with and surpasses the EC '96 guidelines. The device provides adaptive back illumination, seamless digital image masking, white or blue colour rendering, adaptive ambient illumination and film scatter suppression—all automatically. Preliminary clinical evaluation demonstrates the marked improvement in lesion detectability associated with this device. Each paragraph of Chapter 1, Clause 11 of the *European Guidelines* is presented and its psychophysical rationale discussed. A hands-on demonstration will enable radiologists to experience the improvement of their reading acuity using a viewing device which ensures compliance with the aforementioned standards *vs* reading films with a conventional light box.

Mobile digital rotational fluoroscopy: a new imaging modality

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This exhibit demonstrates the operation and use of a new, mobile, medical imaging technology. Fluorotomography (FT3, Integrated Dynamics Ltd, Cambridge, UK), is a mobile image acquisition and processing workstation which allows digital manipulation (including real-time subtraction) and archiving of dynamically acquired fluoroscopic image sequences. The FT3 system uses specifically developed Windows-based software and can be easily connected to both mobile and fixed analogue, C-arm fluoroscopy units. Examples of image sequences acquired from different fluoroscopy units in the vascular, hepatobiliary, renal and musculoskeletal systems will be presented, including examples of rotational sequences. The fluorotomography technique allows capture of images at up to 25 frames per second during rotation of a standard C-arm fluoroscope and provides immediate replay of rotational image sequences. Direct, three-dimensional anatomical interpretation is achieved through the kinetic depth effect (KDE) thus avoiding complex and time-consuming software reconstruction. Research into the potential use of fluorotomography in the musculoskeletal and vascular systems will be presented.

Computerized patient dose monitoring in diagnostic radiology

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The measurement of patient entrance surface dose (ESD), dose-area product (DAP) and effective dose (ED) is common practice in X-ray departments throughout the UK. However, patient dose monitoring can often be time-consuming and labour and data intensive. A time efficient computerized system of patient dose monitoring with user friendly interfaces written in "Labview" is presented. The need for laborious TLD processing and form filling is obviated. CONVENTIONAL X-RAY: Exposure factors and patient details are collected from each room and entered onto the computer via the "*DOSECAL*" software. X-ray tube output data are selected from a database of annual radiation QA measurements. ESDs are calculated using backscatter factors selected automatically from data contained in NRPB SR262 (adults) and NRPB SR279 (children). EDs and individual organ doses are calculated from the derived ESDs (and/or DAPs if available) using conversion coefficients selected automatically from NRPB SR262 and NRPB SR279. FLUOROSCOPY: A laptop computer containing the "*DAPDOSE*" software interfaces directly with the DAP meter in the field. Patient and examination details are entered onto the computer via a single, input screen before the examination. After the examination has been performed, the DAP is recorded onto a database with the other details and the DAP meter reset automatically. Both systems have proved very useful in both our routine patient dosimetry programme and in incidents involving patients receiving radiation exposure greater than intended. "*DOSECAL*" has been particularly useful in assessing fetal doses from exposures of pregnant women.

A new wavelet based compression algorithm optimized for medical images

J Monaco
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Image compression is an essential technology for efficiently using the limited communication and storage resources available in distributed medical environments. At Line Imaging Systems we recognize the importance of this technology and in conjunction with research laboratories at the Georgia Institute of Technology we are developing new state-of-the-art compression techniques for medical images. The results shown in our exhibit will highlight our most recent results, obtained with a new wavelet-based compression algorithm specifically tuned for medical images. JPEG is the existing standard for lossy image compression and uses a relatively old DCT based approach known to suffer from blocking artefacts at low bit rates. Recent research results have clearly shown that approaches based on sub-band/wavelet transform coding outperform JPEG in terms of the rate/distortion trade-off. Line's new compression algorithm uses a computationally efficient wavelet transform based technique that effectively exploits spatial redundancies in the image data. A quadtree searching procedure with adaptive entropy coding is used to exploit correlation between wavelet coefficients both within and across the sub-bands. The resulting algorithm does not suffer from blocking artefacts and image quality is substantially improved at all compression ratios relative to JPEG. Two features separate this algorithm from other wavelet-based implementations currently available in the market. First, the algorithm was originally designed for use over noisy channels. Because of this original design goal, the algorithm can be incorporated with a highly efficient unequal channel protection scheme in which only about 20% of the bit stream must be protected by channel coding. In comparison, both JPEG and other wavelet algorithms are almost uniformly sensitive to bit errors and require substantially more channel protection overhead to protect the entire bit stream. This advantage could be exploited in noisy communication environments that exist in wireless communications. The second feature of our approach is the optimization work being done to maximize image quality for medical images. Knowledge of the statistics inherent to images acquired from each modality can be used to improve substantially their performance. This feature will be demonstrated in the exhibit.

BIR Library & Information Service

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We will once again be demonstrating the services available from the BIR Library & Information Service to all radiographers, radiologists and other professions in allied sciences. The aims of the exhibit this year are two-fold. Firstly, we aim to give delegates hands-on experience of using the CD-ROM literature search facility on two different databases, Radline and Radiology & Nuclear Medicine. Secondly, there will be a link to the Internet so that delegates can see the Librarian demonstrate other databases which are available. Information for a subject enquiry can be searched for on these databases, and citations and abstracts from journal sources obtained. Copies of the new Journal Holdings List and other Library information will also be available for visitors.

Development of a PC-based spreadsheet for automated analysis of MRI quality assurance tests

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INTRODUCTION: The importance of regular MRI quality assurance testing is often underestimated. An automated spreadsheet has been developed to enable simple and rapid analysis of fundamental

tests. DEVELOPMENT: A new set of MRI quality assurance protocols were developed based on the MagNET type-test protocols. These new protocols enable data to be transferred from the images using the proprietary image processing tools typically located on MRI system consoles. This forgoes the need to transfer raw image data. The spreadsheet was developed using Microsoft Excel™. A worksheet was designed for each of the common tests: signal-to-noise ratio, uniformity, ghosting, geometric linearity and distortion, slice profile and width and bar pattern resolution. A graphic user-interface was written using Microsoft Visual Basic™ to ease the entry of data into the spreadsheet. Standard formulae for QA analysis were incorporated in the Visual Basic™ code providing immediate feedback of results. An archive of results is built up through use—these results are represented graphically. Methods of monitoring the scanner performance over time, such as Shewhart-type control charting were investigated and incorporated into the spreadsheet. CONCLUSIONS: The spreadsheet offers a number of advantages for the analysis of quality assurance tests. The PC is a portable, low-cost platform and the software inexpensive and widely available. Fundamental data can be entered swiftly and easily without the need to transfer raw image data. The use of the spreadsheet enables an archive of quality assurance results to be built up and enables informed decisions on action levels to be developed.

Medical imaging and volume visualization software

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FPS will be demonstrating IDL, a medical imaging and volume visualization software package. IDL software is rich in analysis and visualization tools and is able to deal with all types of medical data—MRI, CT, PET and ultrasound. Hundreds of medical physicists, medical researchers and clinicians use IDL every day to gain a clearer insight into their data. IDL provides a greater degree of flexibility and customization than can be found in other medical imaging packages. Users are able easily to import and interact with their data, build custom interfaces for their programs, and even put together complete applications for others to use. IDL runs on all UNIX workstations, Linux, Windows and Mac operating systems. For more information, a demo copy and links to medical imaging sites using IDL visit http://www.floating.co.uk/idl.

Online peer review for biomedical journals? The ESPERE project

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Have you ever tried to email a graphic to an acquaintance whose computer platform, software familiarity and email package you know nothing about? Few researchers have the time or the enthusiasm to sort out this kind of problem, yet today's scientific authors generate most of their written and illustrative material using digital methods such as word-processors or graph-drawing programs. It is also quite likely that they routinely capture data such as scans, X-rays and photomicrographs in a digital form. Despite these developments few biomedical journals—even electronic ones—encourage electronic submission or have attempted to implement their peer review system online. The ESPERE project (electronic submission and peer review) is a consortium funded by the Joint Information Systems Committee of HEFCE and involves eight learned society publishers (including the British Institute of Radiology) and researchers from eight UK universities. ESPERE is investigating the problems of producing and sending text files with a large graphics content electronically. Our research has shown a widespread interest in and enthusiasm for electronic peer review and both authors and referees have pointed out the numerous benefits of such a system. These include reducing time and costs, the possibility of raising standards and experimenting with different models. Although few referees were keen to read articles on screen, most were prepared to receive articles electronically and print them out for review. An example of co-operative software suitable for collaboration between researchers, together with research results, will be on display at the ESPERE stand.

Create your own "ID-Entity"—a user-friendly image database for multiplatform delivery

[1]J M Young, [1]D Johnson, [2]R Sargesson, [3]Group B20b (1998), [3]W Emmerlich and [3]J Crowcroft
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[2]*Information Services Department and* [3]*Computer Science Department, UCL , London, UK*

ID-Entity is a prototype image database written in Java for multiplatform delivery. This is being used to create a radiology library/database of images. The essential features are: input from many media such as digital camera, desk-top scanner or CD-ROM. It can be run on a standard PC or over a network. It is searchable and has a classification structure. Areas of interest or "hot-spots" can be included on the stored images. The associated text and hot-spots can be turned on or off so that it can be used in "exam" or "training" mode. The images can be cut and pasted for inclusion in other applications such as word processing or teaching packages. Future development include other desirable features such as image manipulation and inclusion of video.

An estimation of visual image degradation related to controllable quality factor using JPEG image compression

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Using sequences of JPEG compressed images from three medical modalities (RNI, US, CT), the presentation seeks to ascertain the point within each of the series at which observers are able to detect image degradation. This investigation serves as a precursor to a much larger receiver operating characteristic (ROC) analysis, which is designed to elucidate the exact degree of image compression (controllable quality factor, CQF) at which image degradation becomes visible. Using the JPEG compressor on Corel PHOTO-PAINT 6.0™, 256 levels of CQF can be derived. The present "pilot study" will thus delimit the appropriate "window" of image compression (CQFs) from across these 256 degrees, upon which to carry out the larger ROC study. Original laser film copy images were re-acquired using a monochrome video frame-grabber and/or a CCD flat-bed scanner within the imaging laboratories at DORIS, UCSM. The images were collated into three MS PowerPoint™ presentation shows and written to CD-R for observer viewing. The imaging sequences will be displayed on-screen, and copies of the accompanying questionnaire will be made available for congress delegates to complete. Due to the active nature of the presentation, we would hope to communicate results to delegates at a later date.

Wavelet-based radiological image representation and compression

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This exhibit is based on work to develop and evaluate the diagnostic utility of differential wavelet-based fast image transforms and compressions across radiological pathologies; and to contrast this with established methods (JPEG, full-frame DCT and lossless). Selectively used wavelet techniques are capable of offering significant compressions for medical images with a low apparent psychovisual impact. Unlike many established transform-based image compression schemes, extensively developed for generic/non-medical image uses, wavelet-based techniques can be targeted to image structure and are based on both global and local detail, allowing novel locally adaptive enhancements and compressions, and offer compactly coded image representations. Software tools have been developed on a PC platform to implement standard, non-standard and adaptive wavelet transforms of several families on image data, and perform image manipulations and analyses of resulting representations. A database of well differentiated pathology types (localized, extensive, scattered; linear, structured, diffuse) and locations (structured, noisy, uniform), compiled to evaluate the performance of these tools for local archiving and distributed transfer, is available to illustrate the compressive techniques. A multimedia demonstration of resultant images and their physical image quality assessments, using quantitative measures (RMSE, image-global and structured peak SNR) *versus* information entropy measures of compressibility, for a representative sample of the pathologies across wavelet-based and conventional schemes will also be presented.

Monday 1 June

1000–1050
Work in Progress
Radiation Protection/ Dosimetry
Hall 10b

1000
CT Scanner National Dosimetry Survey
S Edyvean, M A Lewis, S A Sassi and A J Britten
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There are approximately 370 CT scanners installed and currently in use in the UK, with nearly a hundred different named models. Over half of these scanners are not covered by the Monte Carlo calculations and associated datasets generated by the National Radiological Protection Board, and published in 1991. This means that for a large number of scanners there is no easy method to estimate organ and effective dose. To address this problem, a national survey funded by the Health Care Medical Division of the Department of Health was initiated in April 1997 to collate a number of dosimetry measurements from a wide range of CT scanner models installed in the UK. A set of measurements was devised to characterize scanner models to enable the newer scanners to be matched to the appropriate Monte Carlo dataset. 30 centres from around the UK and Europe are contributing data to the survey. Four series of measurements designed to characterize important aspects of the CT scanner performance, such as beam quality and beam shaping filter, are carried out and the full programme of measurements is estimated to take between 5 and 7.5 h per scanner depending on the model. A number of measurement datasets has been received and we are already in a position to classify some of the unknown scanners. This paper will discuss the measurement methodology and will report on the progress of the survey with some initial results.

1010
An investigation of patient doses for routine examinations in Irish hospitals
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It must be ensured for all patients undergoing a diagnostic radiological procedure that the benefits of ionizing radiation are greater than the risks to them or their descendants as a result of any exposure. With the implementation of the European Commission Patient Protection Directive (1997), European reference levels will be recommended which are similar to those established by the National Radiological Protection Board. Current Irish dose reference levels have never been published, so it is not known whether dose levels or radiographic practices in Ireland are similar to those in the UK or the rest of Europe. It is essential that Ireland establishes its own reference dose levels according to its own radiological practices. The aim of this study is to establish Irish national reference dose levels for the most common examinations, the posteroanterior chest, abdomen, pelvis and lumbar spine. 16 Irish hospitals were randomly selected and measurements of entrance surface dose using thermoluminescent dosemeters were performed on 60 patients in each hospital. Preliminary results show significant interhospital differences for these common examinations and, more importantly, dose values for these investigations are very different from those recorded by the UK. These results provide evidence that each country must produce its own reference dose levels to ensure that European dose levels are realistic for all Member States.

1020
Radiation dose reduction using a computerized method of patient positioning—clinical trial results
M McBride
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A major cause of over-exposure in diagnostic radiography is due to inaccurate patient positioning. Following an intensive study of anatomical measurements with the aim of formulating a database, a positioning device is being used in clinical trials to measure the level of accuracy of patients being positioned for routine lumbar spine examinations. These results are compared with conventional radiographic techniques. This device is also used to check the focus-to-film distance accuracy and patient movement. A CCD camera recording system is used in conjunction with retroreflective markers which are placed onto patients using the conventional anatomical landmarks normally chosen for anteroposterior and lateral projections. By using the study's anatomical database related to patient size and anatomical structure, patients are automatically positioned using this device. During the calibration of the camera system, the focus-to-film distance is recorded to ensure the required distance is set. Patients are also monitored for movement before and during X-ray exposure. The work-in-progress study population comprises 270 patients; 135 studied employing the device and a further 135 patients employing conventional methods. The total number of radiographic projections undertaken was 540. The percentage of accurately positioned patients using the device was found to be 90% with an actual repeat rate of only 1.4%, *i.e.* only three projections were beyond the acceptable level necessary for repeat. Using conventional methods of patient positioning, the percentage of accurately positioned patients was 35% with an actual repeat rate of 9.6%, *i.e.* 26 projection were repeated. The accuracy achieved by using the computerized device suggests a significant reduction in radiation dose to patients.

1030
The use of a semiconductor detector for measuring low dose scattered X-radiation
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PURPOSE: Scattered radiation is produced in every X-ray examination and therefore is a contributory factor to patient effective dose. Scattered radiation is difficult to measure with conventional dosimetry equipment due to lack of sensitivity. To measure the scattered radiation dose received by the patient during extremity radiography, a more sensitive dosemeter is required. This work involves the initial implementation of the chosen detector. MATERIALS AND METHODS: A passivated implanted planar silicon (PIPS) detector was selected using criteria based mainly on stability, sensitivity (the ability to measure doses in the nGy region) and size (the detector had to fit inside an anthropomorphic phantom in order to estimate organ doses). The custom-built detector utilizes a silicon wafer (14 mm^2, 500 μm thick) with a beryllium window with appropriate housing mounted on a pre-amplifier to minimize electrical noise. The scattered photons are represented in a spectrum which is analysed by a multichannel analyser. Work has been carried out at the National Radiological Protection Board which should enable the data to be converted into an absorbed dose by the use of appropriate coefficients. RESULTS: Early results suggest the PIPS detector is able to measure scattered radiation at clinical exposure levels and in a useful energy range of 8–100 keV. Other initial results demonstrate a linear correlation with exposure (mAs) and thermoluminescent (TLD) data. CONCLUSION: The PIPS detector will be used to estimate the effective dose in extremity radiography. The results available to date will be presented.

1040
The cost effectiveness of radon remediation programmes in NHS properties, domestic housing and schools
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Employers and householders in areas of the country with high radon levels are encouraged to assess radon dose and take remedial action if levels exceed the action limits. Several theoretical studies in other countries have indicated that remediation programmes in domestic housing are cost-effective when compared with the costs to society from radon. We have reviewed the cost-effectiveness of such programmes in domestic housing in Northamptonshire and found that it is similar to that suggested by the theoretical studies, but only if all householders, who discover raised levels, proceed to remediation. In reality few do, reducing cost-effectiveness to that in the NHS workplace which is five times less. At this level, a radon mitigation programme can still be justified as it is more cost-effective than the recent NRPB programme to reduce patient dose from dental X-rays. In schools in Northamptonshire the high activity and increased air flow significantly reduces radon levels, but the radon mitigation programme has been very cost-effective due to the large number of pupils.

1345–1445
Work in Progress
Neuro & Trauma
Hall 11a

1345
T_2 hyperintesities in children with neurofibromatosis type 1: a proliferative potential

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PURPOSE: To evaluate the natural history and neoplastic potential of areas of high signal intensity shown on long TR sequences (UBON: unidentified bright objects in neurofibromatosis) in children with neurofibromatosis type 1. MATERIAL AND METHODS: 46 children with clinically proven neurofibromatosis type 1 underwent MRI examination at the Hospital for Sick Children, Toronto, during 1992/1993. The scans were reviewed along with previous and subsequent serial examinations. The number, volume, distribution and change with time of the UBON were recorded. RESULTS: UBON were found in 43/46 (93%) of the children and occurred most commonly in the globus pallidus (30.4%), cerebellum (23.5%) and mid brain (16.2%). They were uncommon below the age of 4 years, numerous and largest in volume between 4 and 10 years and regressed in children older than 10 years. Eight non-optic pathway tumours were demonstrated in 7/46 (15%) children. MR documented the evolution of five tumours from UBON. Two were present on initial MR, located in the mid brain and cerebellum. Tumours developed in older children (aged 7–12 years) with a higher than average UBON load. Only one child was symptomatic from the tumour. CONCLUSION: UBON occur commonly in neurofibromatosis type 1. They are most prevalent between the ages of 4 and 10 years. Most are benign and regress with age. We found a large number of asymptomatic brain tumours and documented their evolution from or in association with UBON. Young children with high UBON number/volume should be closely followed up with regular MRI because of the increased risk of proliferative change.

1355
The identification of cerebral volume changes in treated growth hormone deficient patients using serial 3D MR image processing

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PURPOSE: To evaluate accurately cerebral volume changes in growth hormone (GH) deficient patients treated with GH using serial 3D MR image processing. MATERIALS AND METHODS: Spoiled gradient echo (3D FLASH) volume MR scans were obtained in five patients and six similar age controls. The patients were scanned before treatment and after 3 and 6 months of GH therapy. The normal subjects were scanned at the same intervals. A phantom was scanned on the same day as each subject, and used to quantify scaling errors due to changes in scanner calibration. The second and third volumes were each registered to the baseline image by maximizing mutual information, and transformed using sinc interpolation. The registration was performed with and without brain segmentation, and with and without correction of scaling errors. Each registered and transformed image had the baseline image subtracted to generate a difference image. Visual assessment of the difference images by two separate neuroradiologists, blinded to the origin of the images, is underway to compare structural changes in the two groups and assess the qualitative effect of segmentation and scaling error correction. RESULTS: Our preliminary results show a probable increase in cerebral volume and reduction in CSF volume in the GH treated patients with insignificant changes in the first two control subjects evaluated. We will present our complete results.

1405
Introducing a new projection technique to map the sulcal pattern of brain MR images onto a 2D plane

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PURPOSE: The complex task of evaluating the sulcal pattern of brain images can be simplified by projecting the surface geometry onto a plane. The ability of this technique to allow interindividual comparisons is examined in a study of twins. MATERIAL AND METHODS: We obtained MRI volumes (Philips S15-ACS, Flash-3D, TR = 17 ms, TE = 5 ms, flip angle 35°) from 14 healthy male twins (7 monozygotic, 7 dizygotic) with 3 mm coronary slices. The brain was segmented and, in a simulation process, surrounded by a spherical electrode of constant potential value. The brain area itself was assigned to zero potential. In the intermediate space, the Laplace equation $\Delta E = 0$ was solved numerically. Field lines were drawn from any border point of the brain area towards the outer sphere. The unwrapped sphere with the number of field lines per area unit was used as the 2D representation of the sulcal pattern. RESULTS: The characteristic 2D pattern shows a high similarity between twins which allows a visual assignment of the twin pairs. Global correlation coefficients of each pair of brainprints yield higher values for monozygotic twins (average 20.2, range 12.3–25.6) than for unmatched pairs (average 13.0, range 1.1–28.5), the difference being statistically significant: U-test, $p = 0.004$. The correlation of the dizygotic pairs shows no significant difference from the unmatched pairs. CONCLUSION: With this method, it is possible to map location and depth of the sulci to a 2D plane. The resulting maps allow quantitative interindividual comparisons of the sulcal pattern of the brain.

1415
Assessment of the cervico–thoracic junction using digital rotational fluoroscopy—comparison with the swimmer's view

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Standard anteroposterior and lateral radiographs are often inadequate for the assessment of the cervico–thoracic junction in patients with suspected cervical spine trauma. In these cases other routinely performed films include the swimmer's view. However, this projection often requires repeat attempts to obtain a satisfactory exposure. This study compares the accuracy and diagnostic confidence of the swimmer's view with a new mobile medical imaging technology using digital rotational fluoroscopy. Fluorotomography (FT3, Integrated Dynamics Ltd, Cambridge, UK) is a mobile image acquisition and processing workstation that allows digital manipulation and archiving of fluoroscopic image sequences. The system can be easily connected to a mobile C-arm and allows the capture of images at up to 25 frames per second during rotation of the C-arm, providing immediate replay of rotational image sequences. These sequences achieve three-dimensional anatomical interpretation through the kinetic depth effect (KDE). Following ethical approval, 40 patients with suspected cervical spine trauma who require a swimmer's view are being recruited to undergo a digital rotational fluoroscopic study. Phantom studies demonstrate reduced patient dose and acceptable operator dose when compared with a swimmer's view. Results of this study will be presented, including analysis of data for comparative diagnostic confidence and accuracy as well as intraobserver and interobserver variation. In conclusion, digital rotational fluoroscopy potentially provides a more accurate and reproducible lower dose technique than standard radiography. The advantages of three-dimensional anatomical interpretation using the kinetic depth effect and versatility of a mobile imaging workstation will be discussed.

1425
Imaging of hamate bone fractures in conventional X-rays and CT: an experimental study and clinical experience

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PURPOSE: Evaluation of the ability to image fractures of the body and hook of the hamate bone with conventional radiography and high resolution CT (HRCT). MATERIAL AND METHODS: In an *in vitro* experiment on 18 cadaver hands, the hamate bone was fractured at different localizations. Before and after fracture, conventional radiographs were taken in different projectional planes: anteroposterior, lateral, oblique and carpal tunnel views, as well as HRCT scans with 2 mm layer thickness in the axial, sagittal and coronal planes. In addition, 15 clinically verified hamate bone fractures (2 body and 13 hook of hamate fractures) were retrospectively reviewed to assess the value of the imaging procedures that led to diagnosis. RESULTS: Taking into account all of the conventional radiograph projections applied, the *in vitro* experiment revealed a sensitivity of 72.2%, a specificity of 88.8% and an accuracy of 80.5%. For CT, the sensitivity was 100%, the specificity 94.4% and the accuracy 97.2%. In the retrospective clinical evaluation, 60% of the

existing fractures were identified on the conventional radiographs. The remaining fractures were detected by additional procedures such as conventional tomography, scintigraphy and CT. CONCLUSION: Fractures of the body and hook of the hamate cannot always be detected with certainty on the conventional radiograph, even if different projectional planes are used. HRCT is the imaging procedure of choice for further clarification, whereby an axial or sagittal plane should be performed.

1435

A new positioning aid for radiographers performing the horizontal beam lateral knee projection

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PURPOSE: At a diagnostic imaging directorate, concern was raised over the high number of rejected horizontal beam lateral knee radiographs. An analysis of these radiographs showed an 82.5% rejection rate due to femoral condyle malalignment (a criterion for the true lateral knee projection). A method of reliably positioning the knee for this projection will be described. METHOD: A novel device was constructed that attaches to the palpable femoral condyles, indicating the correct degree of leg rotation to acquire an acceptable position. The device was tested on cadavers to ascertain its accuracy. RESULTS: The device was 100% accurate at attaining true lateral position on eight cadaveric knees, within a 5 mm margin of error. CONCLUSION: The potential value of the device in preventing repeat radiographs has a direct effect on reducing patient dose, departmental costs and radiographers' time in performing unnecessary repeat examinations. The author is presently testing the device in a clinical trial (results pending).

1545–1625
Work in Progress
Computing/Digital
Hall 11b

1545

Laser *versus* charged couple device digital radiographic scanners: qualitative comparison at different compression ratios

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PURPOSE: For digitization of radiographic film, laser scanners are recognized to have a superior optical density range (quantitative measurements) to charged couple device (CCD) scanners. This study evaluates whether there are qualitative differences between laser and CCD scanners for film digitization. MATERIALS AND METHODS: 50 chest radiographs with subtle pneumothoraces and 50 normal radiographs were digitized on both laser (Lumisys 75) and CCD (Canon 300) scanners. Each film was displayed on a high resolution workstation (2 K × 2 K) at no compression 20:1 and compression 30:1. Four radiologists using a receiver operating characteristic scale (1–5), assessed for the presence or absence of a pneumothorax. RESULTS: For all readers and for all readings (no compression 20:1 and compression 30:1), no statistical difference could be detected between laser and CCD scanners (mean p-value = 0.458) to determine the presence or absence of a pneumothorax. CONCLUSIONS: CCD scanners offer equivalent diagnostic information to laser scanners for digitization of radiographic film. This has cost implications for the installation of a comprehensive PACS/teleradiology solution.

1555

Area measurement and volume creation using simulated materials

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Measurement of areas and volumes is increasingly required in digital imaging, especially for surgical planning and evaluation. This paper describes some new techniques to provide an intuitive method for area measurement using simulated materials and forces. Software has been written to model the materials in real time to give more control over the area measured. The accuracy of the method will be assessed with a comparison of physical measurements of orbits using wax and linear measurements of orbital diameters. The real time 3D modelling and simulation of the virtual materials requires a new technique for volume rendering, using finite element analysis techniques for modelling and moulding the physical properties of the materials and sorting structures to speed up information access and modifications.

1605

Automated registration of similar volumes

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Automated comparisons of areas and volumes of tissue are increasingly required in digital imaging, especially for surgical planning and evaluation. This paper describes some new methods for automatically registering volumes. The aim of the system is to determine automatically the location and orientation of similar volume data in respect to each other; this is useful clinically in evaluating and comparing pre- and post-operation cases. It also has application in other areas of volume comparison, volume matching and feature recognition. The system is being used initially in maxillofacial comparisons. The choice of comparison values and methods are very important factors and are areas that are currently under investigation, the three main techniques that are being investigated are: (1) A fast Fourier transform method for a comparison of spectral peaks on various 2D planes through the volume. (2) Graph theory, creating a 3D graph of the volume information provides a features map of the medical data and would also be useful in other areas of computer vision, for example feature recognition, volume matching and semi intelligent reconstruction system. (3) Fuzzy matching would provide fast comparison data by representing key selected areas or features in the volume and representing them using a set of known shapes. Genetic algorithms are used for focusing and speeding up the comparison functions, the system also learns from its mistakes and successes using genetic selection, therefore improving its accuracy and success rate each time.

1615

Psychophysical analysis of a direct digital X-ray detector

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PURPOSE: The first truly digital X-ray detector, requiring no analogue to digital conversion, is currently in the process of becoming a commercial product. The system is a flat panel array based on amorphous selenium technology. This paper will report on the performance, based on psychophysical measurements, of this detector compared with other X-ray detector technologies. MATERIALS AND METHODS: Exposures of Leeds threshold contrast detail detectability test objects were made with a prototype detector. Exposures were carried out under both low and high kVp beam conditions to allow direct comparison with other digital detectors and conventional screen-film combinations currently available. The raw digital image data for all digital detectors compared were processed, using as closely equivalent parameters as possible and printed on laser hardcopy. All films were viewed by a team of four experienced observers. RESULTS: The results are not available at the time of writing but will be presented at Radiology 1998. ACKNOWLEDGMENTS: This work is funded by the Medical Devices Agency, an executive agency of the UK Department of Health. The authors are grateful for the support of Sterling Diagnostic Imaging in allowing access to the detector.

Tuesday 2 June

1200–1310
Work in Progress
Vascular & Chest
Hall 11a

1200

A novel method of isotropic limb blood flow measurement to predict the level of arterial occlusion

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A nuclear medicine method for measuring limb blood flow during reactive hyperaemia has been developed. This method can predict the most affected site of arterial obstruction. This method has been described by Outif et al on p. 26. Five distinct types of time–activity curves have been observed. (1) Patients with very poor profunda and below knee flow have developed a time–activity curve with negative slope and no rising part of the time–activity curve. (2) Patients with very poor profunda and good below knee flow have developed a fast decreasing (negative slope) followed by a good hyperaemia response curve. (3) Patients with good profunda and below knee flow have developed a good hyperaemia response curve with fast rising phase followed by an exponential decrease. (4) Patients with poor profunda and reasonably good below knee flow have developed a small rising phase after deflation of the cuff followed by exponential outflow with the count rate at the end of the out-flow phase much less than that before cuff deflation. (5) Patients with good profunda and reasonably good below knee flow have developed a rising phase after deflation of the cuff and the decreasing phase has not been reached during the time of the data acquisition (170 s). We believe these differences in the curves are due to the pressure within the venous compartment above the knee, which depends on profunda flow and respiration. The respiratory effect tends to pump the blood back to the heart and hence decreases venous pressure above the knee. In contrast, profunda flow tends to increase the above knee venous pressure.

1210

Rotational digital arteriography of the profunda femoris artery in claudicants—comparison with the standard anteroposterior projection

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The poor correlation between the extent of disease of the superficial femoral artery (SFA) and the severity of lower limb ischaemia indicates the importance of the role of the profunda femoris artery (PFA) in maintaining an adequate vascular flow to the leg via collaterals. In claudicants, isolated SFA disease suitable for angioplasty is relatively uncommon in the absence of coexistent PFA disease. Thus, detection of significant PFA disease is important in patients with claudication prior to minimally invasive treatment. Anteroposterior (AP) projectional views during routine peripheral angiography often fail to demonstrate adequately the proximal PFA, and lateral or oblique views are recommended to visualize the PFA origin. These views, however, require repeat contrast injections and increased radiation exposure. Recent developments in fluoroscopy and digital image processing now provide the ability to record subtracted images during fluoroscopic rotation which provide multiple projections of a given arterial segment during a single injection of contrast. Rotation fluoroscopy sequences can be displayed in a dynamic format allowing multiplanar and three-dimensional interpretation. 25 patients undergoing peripheral angiography are being recruited for a digital rotational fluoroscopic study using a single contrast injection to assess the presence of disease in the proximal PFA. Results of this study will be presented, including a blinded comparison of diagnostic confidence and accuracy using both standard AP and rotational images. Digital rotational fluoroscopy may provide an accurate, efficient and reproducible technique for the demonstration of disease at the profunda–femoral junction.

1220

Evaluation of prospective cardiac gating to reduce cardiac motion on HRCT

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PURPOSE: The authors will describe the application of ECG triggering to improve the quality of high resolution CT (HRCT) of the lungs by reducing cardiac motion artefact. Using partial scan reconstruction with a 0.75 s rotation time, a scan duration of 0.5 s can be achieved. This duration is short enough to acquire images using cardiac gating data during the quiet phase of the cardiac cycle. This reduction in cardiac motion should improve the quality of the images at the lung bases. MATERIALS AND METHODS: Acquisition is performed on a Siemens Somaton Plus 4 Scanner modified to await a trigger signal before commencing acquisition. Trigger signals are automatically generated by a personal computer at a given delay after the R-wave. Following a normal HRCT scan, three levels are selected where cardiac motion may be expected to cause blurring, and triggered acquisition is repeated at these levels. Paired triggered and non-triggered images are then displayed in a random order and scored by two observers for image quality. RESULTS: ECG triggered HRCT was performed on 50 patients. Comparison between gated and non-gated images showed a considerable improvement in image quality in the gated images. There was reduced cardiac motion and distortion of bronchi and vessels. This was most marked in the left lower lobe and lingula. CONCLUSION: ECG triggering improves image quality. Further studies will be needed to assess whether this has an impact on diagnosis.

1230

The use of carbon dioxide contrast agent in renal angiography—the St George's Hospital experience

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PURPOSE: To assess the diagnostic quality of renal angiograms performed using carbon dioxide as a contrast agent, delivered using angiodynamic CO_2ject system. MATERIALS AND METHODS: For a 6 month period between July 97 and January 98 all patients referred for renal angiography had their angiograms with CO_2 as the contrast agent. 30 patients (14 female, 16 male, age range 26–73 years, mean 52 years). Informed consent was obtained in all cases. Indications for renal angiography were hypertension (20), cause of chronic renal failure (10). A standard technique using a 4 french pigtail catheter via the groin was used. Straight AP views with two obliques were used to assess the renal arteries. Volumes between 80 ml^3 and 400 ml^3 in total of CO_2 at flow rates of 60–80 $ml^3\ s^{-1}$ were used. The first 10 cases were supplemented with iodinated contrast angiograms. All CO_2 angiograms were assessed for their diagnostic quality and any adverse reactions to CO_2 were noted. RESULTS: 25/30 patients had CO_2 angiograms of diagnostic quality. 13 were supplemented with iodinated contrast. In five patients the CO_2 angiogram was not considered diagnostic. Six other patients had symptoms related to CO_2 injection ranging from abdominal pain to nausea. CONCLUSIONS: CO_2 renal angiography is capable of producing diagnostic images. The advantage of CO_2 is that in patients with renovascular disease it has no effect on renal function. It is safe in patients with asthma, known previous contrast reaction and diabetics taking metformin. The 6 month trial period involved a learning curve in the use of the CO_2 delivery system to obtain optimal imaging; methods of improved technique will be included in the presentation.

1240

Assessment of aortic involvement in patients with Marfan's syndrome using MRI

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The cardiovascular manifestations of Marfan's syndrome are life threatening. The most important of these is dilatation of the thoracic aorta which can lead to dissection or rupture. MRI is an important imaging modality because it quantifies aortic dimensions and identifies complications, without the need for catheters, contrast media or X-ray irradiation. We report 10 years' experience of MRI in Marfan's syndrome at our centre. 69 patients (43 males, 26 females, age range 10–63 years) who had a proven diagnosis (60) or a provisional diagnosis (9) of Marfan's syndrome were included. 19 patients had follow-up studies over the period, therefore a total of 100 studies was available for retrospective analysis. MRI was the only imaging modality used in 65% of studies. Cardiac-gated spin

echo images were acquired in orthogonal and oblique planes and cine images with and without velocity mapping were acquired in selected planes. Aortic root diameter was ⩾55 mm in 12% and between 40 and 50 mm in 23% of studies. Aortic dissection was shown in 18% of studies (type A in 13%, type B in 5%). Aortic valve regurgitation was seen in 24% (mild 15%, moderate 7%, severe 2%) and mitral valve regurgitation in 8% of the studies (mild 5%, severe 3%). MRI therefore is a valuable non-invasive method of assessing the aorta in patients with Marfan's syndrome and is a useful screening tool.

1250

MRI in the assessment of chronic cavitating lung conditions

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PURPOSE: Over the past 20 years CT has become the gold standard for the assessment of chronic cavitating lesions in the lungs. The radiation dosage of CT is, however, fairly considerable and accounts for a disproportionate percentage of the iatrogenic ionizing radiation received by the population. Bearing in mind the potential hazard from CT, MRI was considered as a replacement in those cases requiring repeated follow-up and an initial study was set up. The MRI scans were obtained within a short space of time of the chest X-ray and CT scan. In most cases, a spiral Siemens Somaton 4 CT and a Siemens 1 T Impact Expert MRI machine were used. The standard MRI sequences used for the chest were a T_2 weighted coronal, T_1 weighted transverse and a STIR transverse followed by intravenous gadolinium-containing contrast media. Breath-hold gradient echo sequences were also used in some cases as well as cardiac-gated video sequences. The smaller lesions were usually seen best on the standard spin echo sequences and this may be due to the problem of susceptibility artefacts at air–tissue interfaces, which is worse on gradient echo scans. MRI only was repeated at subsequent visits. Pathology studied was varied and included viral papillomatosis, bronchiectasis, bronchopulmonary aspergillosis, atypical mycobacterium infection (M. malmoense) with complicating aspergilloma and cystic fibrosis. MRI proved to be a successful means of assessing the cavitating lung and was particularly useful for demonstrating reaction in the surrounding lung tissue. Whilst not having the resolution of the CT scans, MRI did give high tissue differentiation and was adequate for follow-up assessment in all cases.

1300

Computed tomography of the thorax in the follow-up of patients with curative resection of colorectal carcinoma

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PURPOSE: This prospective study examines the role of thoracic computed tomography in staging and follow-up of patients who have received curative surgery for colorectal carcinoma. MATERIALS AND METHODS: From 1990 to 1997, 136 patients, (54 female, 82 males) with colorectal carcinoma, aged 23–74 years (mean age 63.2 years) were assessed. 48 were staged pre-operatively with CT of the thorax and abdomen; the remaining patients had pre-operative chest radiographs. Curative operations were defined as those in which metastases had been excluded by pre-operative imaging and in which the surgeon had removed all tumour, as confirmed by post-operative histological examination of the specimen. After resection, all patients are being followed up with abdominal and thoracic CT at 1, 2 and 5 year intervals. 10 mm contiguous sections are obtained through the thorax, abdomen and pelvis. Intravenous contrast enhanced scans are performed through the liver if hepatic metastases are suspected from the initial examination. RESULTS: To date, a total of 165 CT scans have been performed, of which 140 included complete examination of the thorax. 39 scans (24%) were abnormal, 35 demonstrating local recurrence or distant metastases. Of the 140 thoracic CT scans, five (3.6%) showed isolated pulmonary metastases, four (2.9%) revealed pulmonary and other metastases and three (2.1%) showed primary bronchial carcinoma. The incidence of significant thoracic abnormalities was 8.6% and all were detected within 2 years of follow-up. CONCLUSION: The high incidence (8.6%) of significant pulmonary abnormalities in patients undergoing follow-up for curative resection of colorectal carcinoma suggests that thoracic CT should be included routinely in the follow-up of patients with colorectal carcinoma.

Wednesday 3 June

0900–1030
Work in Progress
Gastrointestinal & Renal
Hall 10a

0900

The assessment of oropharyngeal swallowing in dysphagic stroke using videofluoroscopy

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BACKGROUND: Modified barium swallow procedures are increasingly being used to assess swallowing safety. To date, little data exist which outline the effect of barium consistency swallowing performance in clinical groups. PURPOSE: To explore the effects of two standard barium preparations on swallowing physiology in stroke patients with and without dysphagia. METHODS: 29 hemispheric stroke patients (mean age 67 ± 3 years, 17 male) were studied within 1 week of presentation of their stroke. Analysis was made of two consistencies of barium suspension (E-Z-HD): thick liquid (250% w/v) and thin liquid (40% w/v) in two volumes (5 ml and 10 ml). RESULTS: Comparison of the two groups (normal/dysphagic) was made using a Mann–Whitney U test. All patients in the dysphagic group had significantly longer pharyngeal delay times when swallowing thick barium irrespective of bolus volume ($p = 0.02$):

	Pharyngeal delay times (min ± SE)			
	5 ml thick	5 ml thin	10 ml thick	10 ml thin
Dysphagic	0.68 ± 1.1	0.25 ± 0.27	0.75 ± 1.32	0.38 ± 0.48
Normal	0.04 ± 0.04	0.07 ± 0.08	0.16 ± 0.03	0.01 ± 0.02

All other variables tested showed *no* statistical difference between the groups. CONCLUSIONS: Increases in pharyngeal delay correspond with poor swallowing performance post-stroke. Testing a patient with thick barium increases pharyngeal delay time in a manner not observed in non-dysphagic stroke. This finding has major implications for the assessment protocols used in the videofluoroscopic assessment of dysphagic stroke patients. These implications will be discussed.

0910

A comparison of covered and uncovered Ultraflex metal stents in the palliation of malignant oesophageal stents

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25 patients (15 male, 10 female; mean age 71 years) received uncovered Ultraflex oesophageal stents. 26 patients (16 male, 10 female; mean 73 years) received covered Ultraflex stents. The mean survival rate for the uncovered and covered stent groups was 15 and 14 weeks, respectively. Initial stent placement was satisfactory in both groups. The covered Ultraflex stents required only six replacements; half of these for tumour ingrowth, half for migration. The uncovered Ultraflex stents, however, required 17 replacements; 15 of these for tumour ingrowth, two for tumour overgrowth and one for stent migration. The covered Ultraflex stent is therefore to be preferred for the palliation of oesophageal carcinoma.

0920

Revelation of early ascites as a factor of operability in stomach cancer

A M Ambartsoumian
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Echography is an important method of establishing prevalence and stage in stomach cancer. An important factor for determining the resectability of the stomach is the presence of ascitic fluid. In 50 patients with stomach cancer we revealed 1–5 ml of ascitic fluid. In all patients a small quantity of fluid was diagnosed in the right side below the diaphragm. In 16 cases the presence of a minimal quantity of ascites was observed by a ≥ 1 mm outline surrounding the pancreas in the anechogenous or hypoechogenous zone. Surgery in 47 patients did not suggest the need for a further radical operation, revealing little peritoneal metastases or spreading of the stomach cancer into neighbouring organs. In three patients we performed a stomach resection or gastrectomy. Thus, an early revelation of ascites is a prognostic factor of operability in stomach cancer. Echography is also recommended from an economical point of view.

0930

Value of radiopaque markers in localizing stenoses in partial small bowel obstruction

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PURPOSE: In difficult diagnostic cases of partial small bowel obstruction, radiopaque markers should simulate food particles localizing the region of obstruction. MATERIAL/METHODS: 20 radiopaque markers (4 mm in size) were administered orally and plain radiographs of the abdomen were obtained at 2 h intervals in terms of quadrant localization and transit time. This investigation was compared with other diagnostic methods. The findings at laparotomy comprised the criteria. To date, 20 patients have been investigated. RESULTS: Confirmation of the clinical suspicion of partial small bowel obstruction was possible with radiopaque markers. The obstruction was localized by long-term focal clustering of markers and dilatation of this small bowel segment and corresponded to the findings at laparotomy. CONCLUSION: Radiopaque, nonresorbable markers can imitate solid foods and non-digestible particles and may obstruct a mild but potentially critical narrowing when results of other imaging studies are normal.

0940

Clinical utility of immunoscintigraphy in the diagnosis of recurrent colorectal cancer

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AIM: In patients with treated colorectal cancer, tumour recurrence should be detected as early as possible in order to maximize the benefit of curative therapy. Defining sites of active disease non-invasively allows accurate selection of patients for surgical or non-surgical therapy. The aim of this pilot study is to assess the clinical impact of imaging using technetium-99m labelled anti-CEA monoclonal antibody. METHODS: Eight patients (2 males, 6 females, age range 45–75 years) have been examined prospectively using $^{99}Tc^{m}$ anti-CEA monoclonal antibody (Mallinckrodt). All patients had elevated serum CEA levels and correlation with other cross-sectional imaging (CSI) techniques was available in all cases. Both planar and SPECT scans were obtained 4 h and 24 h after iv injection of the monoclonal antibody fragment. Scans were interpreted without knowledge of the findings present on other imaging studies. RESULTS: Immunoscintigraphy defined sites of active disease in four patients which corresponded with findings present on other CSI scans. Four patients demonstrated no evidence of active disease; two of these patients were also negative on other CSI scans. In the remaining two patients who were positive on CSI, one had infiltration of the omentum and the other had a 1 cm nodule within the liver which enlarged on subsequent imaging. Serum CEA levels were $< 20\ \mu g\ ml^{-1}$ in the four patients who were negative on immunoscintigraphy. CONCLUSION: To date, scanning with $^{99}Tc^{m}$ anti-CEA monoclonal antibody has allowed high quality imaging and provided additional important information, particularly in the pelvis where interpretation of CSI studies can be difficult in this patient group.

0950

Per rectal drainage of peri-anastomotic abscesses following surgery of irradiated rectal cancer patients

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PURPOSE: To evaluate outcome of per rectal peri-anastomotic abscesses following anterior resection for primary rectal cancer in patients who received pre-operative radiotherapy. MATERIAL AND METHODS: Over a 5 year period, 59 of 175 patients had radiotherapy prior to anterior resection for rectal cancer. Eight of these 59 (13.5%) suffered post-operative complications of peri-anastomotic abscesses despite being defunctioned by loop ileostomy. These were diagnosed by CT scan and/or water soluble contrast proctograms. The patients included seven males and one female (age range 51–82 years; average 68.7 years). Under fluoroscopic guidance a drainage catheter (8 Fr to 14 Fr) was introduced per

rectally through the anastomotic site into the abscess cavity and left on suction drainage. The catheters were removed when no further drainage into the suction bag was present. Repeat contrast proctograms were performed between 4 and 150 days (average 49 days) following the initial catheter procedure to assess abscess size. RESULTS: Seven of eight patients (87%) showed complete resolution of abscess cavity with closure of rectal communication. No peri-anastomotic leak was seen on follow-up contrast proctogram. One patient underwent abdomino-perianal resection due to recurrent peri-anastomotic abscess in spite of repeated drainage, this was attributed to larger communication. Five patients went on to have successful reversal of stoma. Two are awaiting closure of loop ileostomy. CONCLUSION: Pre-operative radiotherapy may be associated with peri-anastomotic abscesses. This may be managed by a simple technique of per rectal catheter drainage, which is a minimally invasive procedure with a high success rate.

1000

Abdominal tuberculosis—clinico-radiological study

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PURPOSE: to define and correlate the role of radiology with the clinical and pathological findings in abdominal tuberculosis. MATERIALS AND METHODS: 59 patients (47 males and 12 females) diagnosed bacteriologically or/and histologically for abdominal tuberculosis were radiologically assessed. Evaluation was based on the analysis of plain abdominal radiographs, gastrointestinal contrast studies (barium meal follow through and barium enema), ultrasonography and computed tomography. RESULTS: Plain abdominal radiography performed on 38 patients were positive in 19 cases (50%). Gastrointestinal contrast examinations in 34 patients were positive in 27 cases (80%). Ultrasound examinations performed on 31 patients were abnormal in 25 cases (81%), while computed tomography performed on 24 patients revealed abnormal findings in 19 cases (80%). Combined radiographic and imaging procedures revealed peritoneal involvement (ascites) in 16 patients (27%), bowel involvement in 36 (61%), mass lesion in 11 (19%), lymphadenopathy in 13 (22%) and organ involvement in 13 (22%). CONCLUSION: There was no single radiological method which provided all necessary information suggestive of abdominal tuberculosis. Although unequivocal diagnosis of abdominal tuberculosis can only be made by culture and histological findings, combined computed tomography and ultrasound findings were the most important imaging tools in the diagnosis of abdominal tuberculosis, while contrast studies helped to assess the extent of bowel disease, hence influencing the plans for surgery.

1010

Patient dose reduction and image enhancement in intravenous urography using computed radiography

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PURPOSE: The wide latitude and high sensitivity of computed radiography (CR) using phosphor plate technology makes this an ideal medium for abdominal imaging. This study aimed to clarify the current importance of intravenous urography (IVU) in England and Wales, before investigating patient dose reduction and image enhancement in a clinical trial. METHOD: A questionnaire was posted to 201 hospitals in England and Wales requesting the total number of IVU studies performed, with details of projections and timings. Clinical trials commenced with entrance surface dose monitoring, using thermoluminescent dosemeters (TLDs), for 30 patients undergoing IVU examinations with a conventional film/screen combination. These surveys provided a base line for clinical trial evaluation using CR. Initial investigations used a range of exposures, imaging a whole body phantom, the Leeds TO10 test object and urinary stones placed on the phantom. Contrast and density were manipulated by the Fuji AC-1 CR system look-up tables. The soft copy images were assessed by radiologists before a protocol for CR imaging was agreed. A clinical trial of 100 patients using the new protocol is now underway. RESULTS/CONCLUSIONS: 118 hospitals returned the questionnaire, reporting 92 754 IVU studies. Films per investigation ranged from three to seven (mean 5.25), demonstrating wide use of the examination. Thus, improvements in image quality and patient dose reduction could offer significant benefits. The monitoring of current practice at the research hospital, using a film/screen combination, showed radiation dose levels matching recent national surveys. Phantom trial results suggest that the study aims are achievable with image manipulation.

1020

Just how important is the 1 minute IVU film?

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The aim of this study is to determine the impact of the 1 minute film on diagnosis. The role of the 1 minute film as part of an intravenous urogram (IVU) series is contested. Reasons for its omission are cost-saving and patient dose reduction. The National Radiological Protection Board and the Royal College of Radiologists issued a recommendation in 1994 that the immediate (and post-micturition) films should not be routinely used, in their collaborative document *Patient dose reduction in diagnostic radiology*. The one existing study has failed to resolve the issue. 150 consecutive IVUs have been performed over a 6 month period. Omnipaque 350 mg ml^{-1} is injected as a bolus via a 19 gauge needle. All patients have a 1 min film and a 5 min renal area tomogram. All the IVU series are analysed independently by two consultant uroradiologists (DR, CP), initially without the 1 min film. The reader is then shown the immediate film and asked if additional diagnostic information is present. To date, 50 IVUs have been read with no additional information gained from the immediate film. We conclude that the immediate film is unnecessary in an IVU examination.

1100–1200
Work in Progress
Audit & Skill Mix
Hall 11b

1100

The value of PET–FDG in the management of patients with malignancy—a clinical audit

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AIM: To assess the value of positron emission tomography (PET) with fluorodeoxyglucose (FDG) in the management of patients with malignancy, in a large regional cancer centre. METHOD: 77 scans of patients with cancer or suspected of having cancer, referred for PET–FDG scanning at the scanner centre, were reviewed. All scans were obtained using a Siemens ECAT EXACT 47. The influence of the FDG scan on management was assessed from the patients' notes and by direct communication with the referring oncologists. RESULTS: 68/77 (88%) of scans influenced patient management. As a consequence of the scan the modality of treatment was maintained but modified in 21 patients (surgical 6; chemotherapy 8; radiotherapy 7), treatment for recurrent disease was initiated in four, systemic rather than localized treatment in 11, palliative instead of curative treatment in six, curative instead of palliative treatment in 12, change of order of treatment modality in two, and no further treatment in 12 patients (no active disease 10; too extensive disease 2). The scans showed more disease than previously suspected (26 scans), less disease than previously suspected (6 scans), showed site of active disease not previously apparent (3 scans), confirmed clinical status (12 scans), distinguished malignant from benign (3 scans) and distinguished active disease from sequelae of treatment (18 scans). Histological confirmation of FDG findings which influenced management was obtained in 25/68 (38%) scans and clinical/imaging confirmation of FDG findings in 8/68 (10%) scans, with no false positive or negative PET–FDG scans obtained. Of the nine (12%) scans where patient management was not changed, four provided information which could have changed treatment, however, one patient died before treatment could be started and in three the clinical imperatives incorrectly overruled the scan findings. Histological confirmation of PET–FDG findings which influenced management was obtained in four of these nine (44.4%) scans and clinical/imaging confirmation of PET–FDG findings in one. One false positive scan and one false negative scan were obtained in these nine. CONCLUSIONS: PET–FDG scanning impacted significantly on the management of the cancer patients studied and resulted in a change of treatment plan in a large majority.

1110
Audit of use of abbreviations on paediatric imaging request forms
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PURPOSE: Communication is the imparting of information. Imaging request forms represent a direct line of communication between clinician and radiologist. Abbreviations are ubiquitous in medicine, and especially prevalent on imaging request forms, where they are often the only details provided. Are they an effective means of communicating clinical information? METHOD: Over a 3 day period, 100 abbreviations were collected from request forms pertaining to: general plain film reporting, screening, ultrasound, CT, MRI and nuclear medicine investigations in a specialist children's hospital. These were listed randomly in the order collected and circulated as a questionnaire to all radiologists in the department, to assess their understanding of terms used. RESULTS: Results indicate an average score of 65/100 correct responses amongst radiologists. 55 of the abbreviations were correctly and 19 incorrectly identified by over 90%. Over half of the respondents misinterpreted a further 16 abbreviations. Several of the misunderstood abbreviations emanated from specialist units or referred to rare syndromes or surgical procedures. CONCLUSION: Abbreviations on their own cannot be regarded as an effective method of communication. A quarter of abbreviations used in this study had more than one appropriate meaning, in one case more than eight different definitions were received, a compounding problem which could have serious implications in clinical practice. We do not recommend the routine use of abbreviations as the only form of clinical information provided on imaging request forms.

1120
A method of establishing diagnostic accuracy of radiographer performed barium enemas
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AIM: Given the emphasis currently being placed on professional standards and accountability, methods of evaluating procedures require to be set in place. A process to establish the diagnostic accuracy of barium enemas is described. METHOD: A prospective study was carried out on barium enemas performed by radiographers and a comparative group of registrars over a 12 month period. Using FORMIC software, a form was designed to record details of the original enema and the subsequent outcome. The bowel was described in six anatomical areas, and the barium enema diagnosis of either normal/diverticular disease, inflammatory disease, polyp or malignancy noted. Patient notes were retrieved after 6 months to ascertain what further examinations, if any, had been performed. Investigations, *e.g.* sigmoidoscopy and colonoscopy, were noted and subsequent diagnosis from biopsy and surgery, as appropriate, were recorded, using the same format. The dates of any further barium enemas examinations were documented. The data were scanned into FORMIC software, and transferred to SPSS for analysis. The original and ensuing diagnoses were compared using Kappa statistics. DISCUSSION: Experience revealed some minor difficulties using this technique: (1) difficulties with the FORMIC software, and (2) problems accessing notes giving a delay on the data collection. This method could, with some refinements, provide a manageable approach to assess the diagnostic accuracy of barium enemas, and allow a comparison of radiographer and radiologist performed barium enemas.

1130
The implementation of a radiographic reporting service for trauma examinations of the skeletal system
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PURPOSE: To evaluate the implementation of a radiographic reporting service (RRS) in four NHS Trusts for trauma examinations of the skeletal system. METHOD AND MATERIALS: The method utilizes a longitudinal design and includes five hospital sites. Measures have been chosen to demonstrate the productivity and effectiveness of radiographer reporting, as well as its impact on patient care and management, and include: (1) accuracy of reports; (2) volume of reporting; (3) speed of report availability; (4) cost information; and (5) satisfaction of users. Baseline measurements are to be analysed comparatively with those taken sequentially during the research. Qualitative data relating to costs and user satisfaction will be analysed thematically, supported by ordinal statistics. RESULTS AND CONCLUSIONS: Early availability of results suggests there are a range of impacts. Comparative data are available for two sites and early analysis suggests that the volume of reporting activity has increased (pre: 70.15%; post: 90.77%). The speed of report availability has also increased as indicated by the percentage of reports available in less than five days (Site A, pre: 29.1%; post: 65.7%; Site D; pre: 67.6%; post: 97.1%). Initial figures for accuracy have shown that for the site calculated to date, radiographer sensitivity and specificity has been in excess of 95%. Progress of the research will be discussed and further results will be presented. (Research funded by NHS Executive, South Thames.)

1140
Evaluation of the implementation and management of skill mix in eight diagnostic imaging centres
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The purpose of this 2 year project commissioned by the Department of Health is to evaluate the costs and effects of the implementation of skill mix in eight different diagnostic centres, referred to as case study sites. The project, which is on schedule, is due to be completed by June 1998. The project will also identify the range of skills and abilities of staff extending their practice in this field and the organizational/managerial issues associated with these changes in working practice. RESEARCH METHODOLOGY: The study design used an exploratory case study employing an embedded multiple case design. This involved a combination of longitudinal and cross-sectional elements: examination over time at each site; examination of associations between the variables of interest. Detailed research protocols have been designed for different skill mix activities: barium studies, obstetric ultrasound, general ultrasound, ultrasound in a community setting, skeletal reporting, X-ray department helpers, nurses requesting X-ray examinations in minor injuries units. A number of different data collection tools has been designed and used: audits of staffing levels, protocols, interviews with managers, staff, purchasers and patients to assess extent of skill mix, staff attitudes and patient satisfaction. ANALYSIS: This is currently underway and includes qualitative and quantitative elements carried out within a framework of an exploratory study. Thematic analysis of the interviews should be completed by May 1998.

1150
Factors contributing to successful performance on a certification examination in magnetic resonance imaging
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This research investigated the relationship between selected background variables and performance of 2546 candidates who took a certification examination in MRI in 1995. Five variables related to training and experience were investigated: (1) type of training in MR; (2) amount of training in MR; (3) years of experience in MR; (4) hours per week in MR; and (5) number of MR scans performed per week. In addition, scores from an entry-level certification examination in general radiography were studied. Results indicated that all six variables were significantly related to MR examination scores, with prior performance on the radiography examination exhibiting the strongest relationship. Implications for policy and practice will also be discussed.

1500–1620
Work in Progress
Ultrasound & Breast
Olympian Suite

1500
US training and diagnosis with the aid of teleultrasound system in the community
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We present the results of a pilot study carried out over 3 months to assess the feasibility and efficacy of delivering training and diagnostic US services by general practitioners (GPs) and radiographers in the community, with the aid of teleultrasound system. The research was a collaborative project with two health centres and a district general hospital. These establishments were linked using integrated systems data networking and BT/VCR 8000/Olivetti

video-conferencing software. US clinics were carried out by the radiographers and GPs on the video links, monitored by the university staff for the purpose of training, quality assurance, US image quality, US technique, interpretation of US anatomy and the diagnosis of pathology. In total, 16 video-conferencing sessions were conducted over a period of 8 weeks, with 64 patients scanned over the ISDN link on an array of clinical conditions. The pilot study demonstrates the usefulness of the video link in US applications, through training establishments with immediate access to second and higher opinion.

1510

Measurement of image quality in teleultrasound

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Compared with other forms of teleradiology, teleultrasound is still in its infancy. Currently, most teleultrasound systems rely heavily on some form of video compression in order to reduce the huge amount of digital data generated to a level which allows transmission along narrow bandwidth lines and display at acceptable frame rates. A number of systems described in the literature use ISDN (Integrated Series Digital Network) connections with ITU H 320 or similar compression. Although this form of compression is extremely efficient, there is no consensus view as to whether it is acceptable or safe in radiology. There are currently no clear guidelines for acceptable levels of image quality in teleultrasound. Many previous studies have looked at radiologist performance in teleultrasound but few have attempted to measure image quality directly. Using a PictureTel videoconferencing system over an ISDN 6 connection we evaluated a number of techniques of image quality assessment. Differences in image degradation were detected using normalized, mean squared error, difference images, histograms, line and surface plots and fourier analysis. The greatest image degradation was seen in images acquired during rapid movement of the probe. The normalized mean squared error measurement demonstrated changes most effectively but is not specific to the type of degradation occurring. The other measurements all showed significant degradation but to a lesser degree. This study demonstrates the ability to measure image degradation effects. It is hoped that the above forms of measurement would be useful in the future implementation of quality standards.

1520

An analysis of the effectiveness of a computer-based information prototype for obstetric ultrasound

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A multimedia computer-based information prototype about an obstetric ultrasound service has been previously assessed in field trials. This study reports on the learning effectiveness of this information prototype. A pre-clinical study preceded a clinical study. The pre-clinical study established the comparative effectiveness of two information methods: the computer-based information prototype and a "traditional" paper-based information leaflet. The content of each were closely matched. Two volunteer groups used one of the information methods. An analogue multiple choice questionnaire (MCQ) was used to assess the baseline and post-learning experience knowledge. The computer group data ($n=35$) indicate the computer-based approach was effective, with mean knowledge increasing from 39% to 74% ($p<0.00001$). A decrease in incorrect responses was also noted from 9% to 3% ($p<0.0005$). This suggests the prototype to be an effective learning method. The information leaflet data ($n=20$) also indicate this approach was effective, with mean baseline knowledge increasing from 53% to 63% ($p<0.002$) and incorrect knowledge decreasing from 9% to 6% ($p<0.01$). Significant differences exist between the two groups' post-learning "correct" responses ($p<0.0001$) and "incorrect" responses ($p<0.003$). These data suggest the multimedia method is superior for imparting knowledge. The clinical study is in progress. The computer-based information prototype is currently located in a community medical practice and an ultrasound department within a major city teaching hospital. As part of the normal routine, patients, their partners and members of the public use the system. For logistical reasons assessment of baseline knowledge cannot be conducted and the post-learning experience knowledge is assessed by on-line MCQ. Items and their syntax are the same for analogue and digital MCQs. This paper will expand upon the pre-clinical study and outline the findings of the clinical study.

1530

The risk of cross-infection by ultrasound transducers and how to reduce it

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Hospital-acquired infection is an important and increasing problem. There has been no conclusive work regarding the cross-infection potential of ultrasound transducers and how this can be minimized. The lack of a clinically effective and practical cleaning protocol may be placing patients at risk. Our aim was to develop such a protocol. A prospective study was carried out in which transducers following standardized abdominal scans of ITU patients were placed directly onto blood agar plates unwiped ($n=40$). The transducers were then cleaned using a single paper wipe to dryness and placed on a second plate ($n=40$). The probes were then further cleaned either by a second paper wipe ($n=20$), or with an alcohol wipe allowing 2 min to dry fully ($n=20$), before placing them on a third plate. The plates were spread and incubated. The number and identity of colony forming units (CFU) were established after 24 h. The transducers transmitted more than 130 CFU (mean) when unwiped. The cleaning process had a statistically significant effect on the mean number of CFU grown: single paper wipe 22; double paper 3; paper and alcohol 0.1. Organisms isolated included methicillin resistant staphylococcus aureus (MRSA) and vancomycin resistant enterococcus. When patients were known to be MRSA positive, we found 40% of the transmission of MRSA occurred from unwiped probes despite most patients being on vancomycin therapy. A protocol for clinically effective transducer cleaning was established using the results of this study which has been expressed as an algorithm for ease of use. This is due to be monitored by audit.

1540

Sonographic demonstration of the brachial plexus

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PURPOSE: To determine the feasibility of visualizing the brachial plexus using ultrasound. MATERIALS AND METHODS: Five normal volunteers had brachial plexus MRI studies performed to define their individual brachial plexus anatomy. The volunteers were then examined sonographically, and the ultrasound and MR anatomy compared. RESULTS: A standard reproducible technique for examining the brachial plexus sonographically was established. The nerves appear as hypoechoic tubular structures, with an internal fascicular pattern. The brachial plexus roots, trunks and cords can be reliably identified in the supraclavicular and infraclavicular regions, with a variable portion inaccessible due to the clavicle. It is not possible to see the roots within the neural foramina, the epidural space cannot be evaluated and the identification of the C8 and T1 roots can be difficult. CONCLUSIONS: Ultrasound examination of the brachial plexus is possible although the technique has limitations. We do not see ultrasound replacing MR as the primary diagnostic tool. However, ultrasound may play a complementary role in the evaluation of patients with brachial plexopathy, by allowing it to guide percutaneous biopsy of areas shown to be abnormal by ultrasound or MR. With greater experience an alternative diagnostic test may be available for patients precluded from MRI.

1550

The usefulness of high frequency ultrasound as a first-line diagnostic tool in non-palpable breast nodules

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PURPOSE: Ultrasonography is helpful in evaluating palpable breast lesions. In this study we analyse the usefulness of high frequency ultrasound (US) as a first-line diagnostic tool in non-palpable breast nodules (NPBN). MATERIALS AND METHODS: Between 1 November 1995 and 15 January 1998, we selected 106 women with NPBN revealed by US. The size of the nodules varied from 3 mm to 32 mm. The women with NPBN detected by US underwent sonographically-guided fine needle aspiration biopsy (FNAB). After FNAB, histological or follow-up examinations were planned. In the case of benign lesions, we planned an initial follow-up examination after 6 months, and 3 months for a lesion which was unclassified. All ultrasound examinations were performed with a 7.5 MHz linear probe. RESULTS: Based on the US examination findings, the disease was diagnosed as malignant in five cases, as most probably malignant in two, as benign in 76, and in 29 cases it was unclassified. Eight patients underwent surgery. In five, the disease was histopathologically proven as carcinoma

(US findings being true positive in all these cases); three were benign lesions, of which two had been sonographically diagnosed as such, and one had been unclassified on US examination. 95 patients were followed up. CONCLUSION: US as a first-line tool in diagnosing non-palpable breast nodules is an accurate technique for distinguishing between benign and malignant non-palpable breast nodules observable sonographically. When unclassified nodules are encountered, a physician faces the decision of whether to perform a surgical biopsy or only to perform follow-up examinations.

1600

Measurement of breast tumour response to hyperbaric oxygen therapy using dynamic Gd-DTPA MRI

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PURPOSE: Hyperbaric oxygen therapy is thought to promote angiogenesis and hence increase capillary surface area within tumours, thus aiding delivery of chemotherapeutic agents. The purpose of this work is to evaluate the response of breast tumours to hyperbaric oxygen and chemotherapy, by estimating permeability · surface area product (k) and extravascular extracellular space volume (v_1) within the tumour, using dynamic Gd-DTPA enhanced MRI in conjunction with compartmental modelling techniques. METHODS: A control group ($n=7$) and a hyperbaric group ($n=8$) were imaged twice prior to chemotherapy for breast tumours. Imaging was performed on a 1 T MRI system acquiring three slices through the tumour using T_1 weighted 2D FLASH. 36 frames were acquired with a temporal resolution of 10 s, Gd-DTPA being injected on the fifth frame. Compartmental modelling provided estimates of tumour k and v_1. RESULTS: Control group k and v_1 measurements showed no significant difference between imaging sessions ($p=0.31$ for k; $p=0.22$ for v_1). In the hyperbaric group, after hyperbaric oxygen therapy, both considerable positive and negative changes were observed in k individually, although overall no difference in k was seen ($p=0.30$), whilst an overall decrease in v_1 was observed ($p=0.04$). CONCLUSIONS: The reproducibility of the technique for measuring k and v_1 has been established. Hyperbaric oxygen was observed to reduce v_1 whilst having no overall effect on k. The significance of this result and the use of hyperbaric oxygen as an adjunct to chemotherapy remains as yet unclear.

1610

Correlation between mammographic findings, ultrasound characteristics and histological grade in patients with breast cancer

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INTRODUCTION: The relationship between the mammographic findings, ultrasound characteristics and the histological grade of breast cancers has not previously been described. The purpose of this study was to assess if the histological grade could reliably be predicted from the imaging characteristics. This may have therapeutic implications, such as selection for pre-operative chemotherapy in grade III (high grade) tumours. METHOD: A retrospective review of the mammographic findings, ultrasound characteristics and histological grade was performed for all patients diagnosed with breast cancer at our screening centre between January 1996 and December 1997. Ultrasound images were reviewed by two experienced breast radiologists with regard to size of mass, margin, echo texture, nature of distal effect and presence or absence of a halo. Corresponding mammographic lesions were assessed for size, margin and density. Based on the combined imaging characteristics a prediction of the histological grade was made. RESULTS: There were 94 screen-detected cancers. To date, 10 patients have been excluded from the study (ultrasound not performed in eight, no mass detected in one and neo-adjuvant chemotherapy in one), leaving a total of 84 patients. Histological grading was as follows: 24 grade I, 27 grade II and 26 grade III tumours. For seven patients no histological grade was listed. 29 cases have been examined to date. Of these, 26 were predicted by imaging characteristics to be of low or intermediate grade; two of these were histologically high grade. Three cases were judged to be high grade, all correctly. CONCLUSION: Preliminary results indicate that in patients with imaging features suggestive of high grade breast cancer, the positive predictive value is high. Larger numbers are needed to confirm this finding, and our study continues to this end.

Posters

National Indoor Arena Concourse Area

Work in Progress

Abdomen

POSTER 0107

Is post-operative death after palliative resection of colorectal cancer related to the liver metastatic load?

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PURPOSE: To determine whether the risk of death in hospital after admission for palliative colorectal resection is related to the extent of the liver metastatic load as determined by pre-operative CT scan and also to determine the relationship between pre-operative hepatic metastatic load and length of survival in those discharged home alive. MATERIALS AND METHODS: Between January 1992 and January 1998, 92 patients on the HOPE CRC Database were classified as elective palliative resections. Those patients with pre-operative CT scans of the liver were identified (46). The volume of the liver that was replaced with metastatic disease was independently scored by two radiologists. If the amount of liver metastatic load is associated with high post-operative death or very limited (3–6 months) post-operative survival we will consider a strategy of no operation and/or stenting of patients presenting with obstructing primary tumours associated with a certain level of metastatic hepatic load.

Audit

POSTER 0203

Clinicians' perception of plain film hot reporting service

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OBJECTIVE: A plain film hot reporting service is provided by the Radiology Department at City Hospital, Birmingham. A survey was performed to establish the perceived usefulness of this service and to identify clinicians' priorities. MATERIAL AND METHODS: 198 questionnaires were sent to doctors in medical and surgical specialities. RESULTS: The response rate (overall 58.9%) was lower for junior doctors (39.3%) than consultants (93.6%). The understanding of which films were hot reported was poor. Only 21.4% of respondents stated that they had received hot reports during the week prior to the survey. These clinicians were more likely (87.5% *versus* 80.5%) to state that the availability of hot reports influenced patient management. More doctors in medical (84.9%) than surgical (74.3%) specialties found hot reports useful. Only doctors who were unaware of having received hot reports stated that the availability of hot reports would never influence patient management (4.5%). Hot reporting for patients admitted through accident and emergency departments was seen as the first priority followed by hot reports for other inpatients. CONCLUSION: Most clinicians perceive plain film hot reporting as useful. Despite the fact that the majority of plain film reports at City Hospital are hot reports, only 21.4% of clinicians were aware of this service. Raising clinicians' awareness of hot reporting facilities might be translated into more efficient use of resources and improved patient management. The majority of respondents felt that Accident and Emergency films should be the first priority for hot reporting.

Cardiovascular System

POSTER 0411

Phlebographic score for assessment of lysability of deep venous thrombosis

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PURPOSE: Definition of phlebographic criteria for thrombosis morphology to assess possible lysability/recanalization effect. PATIENTS/METHODS: Retrospective investigation of phlebography of patients who underwent fibrinolysis of deep venous thrombosis (DVT). By comparing segmentally radiomorphological thrombosis criteria before and after therapy, the prognostic predictor was determined for each criterion. These results were analysed referring to: (1) thrombosis localization; (2) thrombosis duration; (3) therapy duration and (4) development of collateral veins. RESULTS: There is a definite correlation between radiomorphological signs of thrombosis and therapy outcome. This finding is: (1) different depending on thrombosis localization; (2) not definitely depending on thrombosis duration given by patients' history; (3) affected by the duration of therapy; (4) only partially dependent on formation of collaterals. CONCLUSION: The presented phlebographic score is a prognostic aid to assess possible recanalization of DVT when fibrinolysis is considered as treatment. It seems to be more objective than thrombosis duration as an evaluation tool.

Chest

POSTER 0606

Interobserver variation in evaluation of segmental and subsegmental thromboembolism with high resolution CT pulmonary angiography

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PURPOSE: Helical CT is known to be accurate in the diagnosis of pulmonary thromboembolism to the level of segmental pulmonary arteries. Recent work with a thin section technique allowing the clear depiction of subsegmental vessels suggests that subsegmental emboli can now be reliably diagnosed. The purpose of this study is to evaluate the degree of interobserver variation in the diagnosis of segmental and subsegmental emboli. METHOD: A minimum of 100 patients are being recruited for evaluation of a CT pulmonary angiography technique using a sub-second (0.75 s) helical scanner (Siemens Somatom Plus 4). The protocol consists of a contrast enhanced helical scan of the pulmonary arteries using the following parameters: collimation 2 mm, pitch 2, reconstruction interval 1 mm, scanning volume 10–15 cm using a bolus tracking technique with 150 ml 240 mg ml^{-1} iohexol contrast. Each scan is independently reviewed by five radiologists (3 consultants and 2 specialist registrars) who are blinded to clinical details. Each pulmonary arterial segment is scored for the presence of segmental or subsegmental thrombus. In the case of subsegmental thrombus a confidence level is indicated. RESULTS: 29 patients have been imaged and there is good correlation in the evaluation of lobar and segmental thrombus. However, only one patient to date has been thought to have isolated subsegmental thrombus. It is hoped that further assessment of interobserver variation in the evaluation of subsegmental thrombus will become possible with a larger number of patients on completion of the study.

POSTER 0607

Alternative diagnoses and incidental findings in patients undergoing CT pulmonary angiography for suspected pulmonary embolism

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PURPOSE: Helical CT pulmonary angiography (CTDA) is being increasingly used in the diagnosis of acute pulmonary embolism and has the advantage over ventilation-perfusion (VQ) scintigraphy of providing simultaneous anatomical information on lung parenchyma, pleura and mediastinum. The purpose of this study is to assess the frequency of additional findings and alternative diagnoses provided by CTPA alone compared with VQ scintigraphy and chest radiography. METHOD: A minimum of 100 patients are being recruited for evaluation of a CTPA technique using a sub-second (0.75 s) helical scanner (Siemens Somatom Plus 4). The protocol consists of a contrast enhanced helical scan of the pulmonary arteries with the following parameters: collimation 2 mm, pitch 2, reconstruction interval 1 mm, scanning volume of 10–15 cm and a bolus tracking technique using 150 ml 240 mg ml^{-1} iohexol contrast. Scans are reconstructed with both a soft algorithm for assessment of pulmonary arteries and a high resolution algorithm for assessment of lung parenchyma. Further helical scans of the apices and

bases are obtained (collimation 8 mm, pitch 1.5). Each scan is independently reviewed on a workstation by five radiologists (3 consultants, 2 specialist registrars) who are blinded to clinical details. Additional findings are recorded, including assessment of lung parenchymal abnormalities. Review of the patient case record is made to assess the relevance of these findings to clinical presentation. CONCLUSION: 29 patients have been imaged to date. Initial results suggest that additional findings are common (emphysema, lymphadenopathy). However, the relevance of these findings to clinical presentation will not be known until completion of the study.

Education

POSTER 0709

Clinical decision making in diagnostic radiography—a two centre study

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PURPOSE: Understanding how radiographers make decisions is becoming recognized as an important key to the general understanding of how radiographers carry out the tasks that comprise diagnostic radiography. This poster describes work undertaken in two centres (University of Hertfordshire and Olou, Finland) to explore issues relating to an explanation of how radiographers make decisions about techniques, exposure factors and selection of imaging methods. The general aim of the study (funded by the British Council) was to explore the "cognitive level" or "task structured level" at which clinical decisions are made. Two very different centres were selected to explore the impact of contrasting educational models and to introduce a Europe-wide perspective. This study will form the basis of a larger project. MATERIALS AND METHODS: The data were collected from Finnish and English imaging departments. Two groups of radiographers were matched and were presented with a number of clinical scenarios. The radiographers were invited to respond to the scenarios presented by recording their reactions on questionnaires provided and think-aloud techniques were employed. The questionnaires invited radiographers to react to specific cues placed within the scenarios. RESULTS: Data collection is ongoing and final results from the project will be presented indicating: (i) the methods and levels of decision making used by radiographers and (ii) differences between centres. CONCLUSIONS: This study will help in adding to the understanding of clinical decision making and indicate areas for further research.

POSTER 0710

The patients' perspective—are we satisfying their psychological needs?

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PURPOSE: This research was carried out to collect data on the hypothesized connection between patient anxiety and information. MATERIALS AND METHODS: The preliminary phases of the study involved qualitative research to derive patients' conceptualizations of the barium enema. Data gathered were used in the development of an information leaflet and questionnaires for this phase of the research. This phase was quantitative and looked for relationships between information and anxiety in an attempt to explain causality after directly influencing clinical practice. Two questionnaires were designed (pre- and post-examination) and used alongside Spielberger's State Trait Anxiety Inventory. The patients were randomly assigned to one of two groups, one receiving standard hospital information, the other receiving the leaflet designed for this study. RESULTS: The results from the research showed that patients attending for barium enema did show increased levels of anxiety and that those who received the information leaflet designed for this study had lower changes in anxiety levels and showed greater feelings of having sufficient information compared with those who received the standard hospital information. CONCLUSION: There is a need for further follow-up of the effectiveness of information given regarding X-ray examinations, so that the future will see more comprehensive standards of care laid out by Trusts. It is envisaged that this would include a minimum level of information for patients in an effort to raise quality standards and patient satisfaction.

POSTER 0711

The use of a computer programme to investigate decision making methods used by diagnostic radiographers

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PURPOSE: The function of this research is to develop a computer based multimedia program to ascertain information about the methods used by radiographers in decision making. MATERIALS AND METHODS: The program development team was set up, consisting of one research assistant, two senior lecturers and three undergraduates, to produce the prototype. The basis for the development of the prototype is storyboards concerning particular radiography examinations. The storyboards will cover particular radiography examinations from beginning to end, giving choices for the respondents to take as to "what they would do next" with a system integrated to enable monitoring of what choices have been made. Potential users (student radiographers, clinical lecturers, lecturers, radiographers) will be involved in the design and development of the prototype. A first draft storyboard will be compiled and the potential users will be asked to offer constructive criticism about the content, usability and how the media were represented. The suggestions will be used to inform the design process in an iterative fashion. RESULTS: It is possible to develop easily a computer based program to gain information on the "potential" choices radiographers make for each particular examination. A log of the decision making trail will be made for each examination by each person. CONCLUSION: This research will provide quantitative data concerning decision making processes of radiographers.

POSTER 0712

Defining decision making in radiography—the "think-aloud" technique

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PURPOSE: Tracing the actual process of thinking as it occurs is the ideal method of understanding and determining the decision making processes of radiographers. Think-aloud techniques are well established in the field of occupational therapy; however, these have not yet been used in radiography. The purpose of this research is to develop a think-aloud protocol for decision making in diagnostic radiography. MATERIALS/METHODS: 20 senior I radiographers were used in the development of the protocol. The subjects were given scenarios and asked to "think-aloud" what they would do in a clinical setting. Each subject's think-aloud session was recorded on audio tape. The tapes were transcribed and used to develop a think-aloud protocol. RESULTS: The development of this method of tracing thought processes is ongoing. Final results will be presented showing the emerging themes and use of this method in a clinical and educational setting. CONCLUSION: The think-aloud method is a simple yet effective technique which allows the description of the steps a radiographer takes to come to a conclusion and therefore make decisions. It is envisaged that this method will aid in the understanding of decision making in radiography.

Musculoskeletal

POSTER 1126

MRI and ultrasound measurements of lower limb torsion

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This paper evaluates real-time ultrasound and MRI measurements of lower limb torsion in 27 patients with patellofemoral pain syndrome (PFPS). As part of a clinical appraisal, 40 patients with PFPS had real-time ultrasound measurements of each of right and left femoral anteversion (FAV), tibial torsion (TT) and femorotibial rotation (FTR), performed by one observer (ASK). MR images were obtained of both lower limbs using spin echo T_1 axial images at the hips, knees and ankles of each patient. Using the MR images one observer (ASK) made measurements of each of FAV, TT and FTR by selecting equivalent reference lines used in the ultrasound measurements; this was possible in 27 sets of images, the remainder (13/40) did not display acceptable reference lines. The subjects (20 females, 7 males) had a median age of 16 years (range 7–33 years). The MRI measurements were repeated several months later to assess intraobserver reproducibility: FAV $\pm 4.7°$ to $\pm 6.5°$; TT $\pm 4.2°$ to $\pm 6.2°$; FTR $\pm 3.1°$ to $\pm 4.5°$ (95% confidence

limits). Variances for each of FAV, TT and FTR from MRI measurements are not significantly different from those of ultrasound measurements (variance ratio test). MRI findings show a very highly significant correlation with ultrasound measurements ($p < 0.001$) but there are differences between MRI and ultrasound data for each of FAV, TT and FTR of 0–4°, some of which are statistically significant (paired t-test). MRI measurements (except right TT) are less reproducible than real-time ultrasound measurements. Our findings support the continued use of real-time ultrasound for the measurement of FAV, TT and FTR.

Oncology

POSTER 1205
Odyssey
L Causer
Oncology Directorate, Kent & Canterbury Hospitals NHS Trust, Canterbury, Kent CT1 3NG, UK
Odyssey uses physical and creative challenges to help people with cancer combat some of the emotional and psychological devastation caused by the illness so that they can regain their zest for life. Designed to help men and women recovering from cancer or in remission, it is a 5-day adventure using the stimulation of uncertainty and surprise to help participants rebuild confidence and vitality through meeting unexpected new challenges which often involve an element of risk-taking. An adventure without compulsion using the widest variety of stimulating challenges—mainly in the outdoors. The momentum which Odyssey creates helps participants stretch themselves beyond what anyone else could make them do and fosters a climate in which it becomes natural to give and be able to ask for support. Odyssey also draws on art and music, the majesty and power of the environment and the beauty of nature to feed the spirit so that at the end of the week, participants are ready to seize hold of life again with both hands, having enhanced their confidence, self-respect and vitality and recognized that they have strengths, dignity and untapped personal resources on which to draw. Led by highly qualified and experienced outdoor pursuits experts used to helping men and women conquer challenges of which they would not previously have felt themselves capable, the essence of Odyssey is to help participants turn their battered souls outward again.

POSTER 1206
Transcatheter hepatic artery infusion chemotherapy and embolization for 75 patients with primary hepatic carcinoma
Q-S Zhang
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75 patients with primary hepatic carcinoma (PHC) were treated with transcatheter hepatic artery infusion chemotherapy (TAI) and embolization (TAE) from March 1989 to January 1991 (68 males and 7 females; age range 23–71 years, average 50 years). The course of disease ranged from 0.5 to 12 months. Of these 75 cases, 43 had stage II and 32 had stage III lesions. Using Seldinger's method, conventional hepatic angiography was performed. Afterwards, adriamycin or cisplatin infusion was carried out, followed by chemoembolization therapy of tumour vessels using a mixture of ethiodized oil or iophendylate and mitomycine. Finally, a gelatin sponge block was used for proximal arterial embolization. After the treatment procedure, abdominal pain was relieved and the tumour reduced in size. AFP declined to various degrees and the survival time was prolonged to 3, 6, 12 and 24 months in 71, 42, 12 and 2 cases, respectively. It is indicated that TAI and TAE, being safe and effective, comprise the treatment of choice for patients with unresectable PHC.

POSTER 1207
The role of radiomodifiers in radiotherapy of rectal cancer
S K Karamian, A Z Alexanian and N S Karamian
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During recent years the use of different chemical and physical modifying factors in the treatment of malignant tumours during independent or pre-operative radiotherapy has been widespread. Local induced hyperthermia (165 patients), synchronization of the cycle of tumour cell division by 5-FU (81 patients), short-term artificial hyperglycaemia (17 patients) and combined application of synchronization and the hyperglycaemia (25 patients) have been used in 222 cases of the localized inoperable rectal cancer (T4N01M0). A comparative analysis of the immediate, near future and distant future results of radiotherapy with no modifiers of the 211 patients with the same stage of disease was carried out. In the test group the tumour regressed enough to allow radical operation in 55.4% of the cases and in 80.2–87.3% ($p < 0.05$) in the group being analysed. The 5-year survival rate of radically operated upon patients was 66.6% and 65.2%, respectively. The 10-year survival rate was 49.5% and 60.7% of cases, respectively. Our experience testifies to the effectiveness and good prospects of the use of the radiomodifiers in radiotherapy, especially the combination of the effects of the syncronization and hyperglycaemia, which are simple to use clinically, economical and do not require any special equipment.

Physics

POSTER 1312
kV and mAs relationships: the 15% rule
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An understanding of the relationship between kV and mAs is fundamental to radiographic exposure technique since a change in kV must be accompanied by an appropriate change in mAs in order to maintain constant film blackening. The 15% rule implies that the mAs and kV are linked by the relationship, $mAs \propto 1/kV^5$. A power term of 5 indicates a strong dependency on kV. This is the result of the effect of kV on each of the three components of the imaging chain, namely tube output, attenuation and film/screen response. Experimental and theoretical investigations of the mAs/kV relationship of each of these components are presented in order to determine their individual contributions to the resultant power term. It is shown that the power term is largely dependent on the kV range employed, the patient thickness and the type of film/screen combination. Under such circumstances the validity of the 15% rule may be limited.

Radiotherapy

POSTER 1504
The proliferating ability of haemopoietic cells under hypoplasia after chronic γ-radiation
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The proliferating ability of bone marrow cells has been evaluated in persons exposed to long-term chronic γ-irradiation by the methods of short-term culture of bone marrow cells with H^3-thymidine, autoradiography of samples and mitotic index. We have observed expressed hypoplasia granulocytopoietic cells of bone marrow in patients following radiation exposure. The doses were greater than 0.5 Gy per year, the total doses being 2.0–4.0 Gy. The period since contact with ionizing radiation sources was 25–30 years. The research results have been compared with data received during the examination of a control group of healthy subjects. Under expressed hypoplasia granulocytopoiesis we found a significant decrease in the proliferating pool of granulopoietic cell bone marrow. There were decreases in the number of marked granulopoietic cells and in marked intensity. We observed the compensatory reaction of erythronormoblasts, enabling the maintainance of erythrocyte production at the necessary level.

POSTER 1505
Outcomes of treatment of adenogenic uterine cervix cancer
S E Shelkovitch and E E Vishnevskaya
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PURPOSE: To estimate the efficiency of different methods of treatment of acinar uterine cervix cancer. MATERIALS AND METHODS: At the Research Institute of Oncology and Medical Radiology, between 1988 and 1991, 267 acinar uterine cervix cancer patients were treated. 185 patients received combined modality treatment, 77 combined (external and intracavitary) irradiation and five symptomatic therapy. Combined modality treatment included surgical intervention in combination with radiotherapy in pre- and post-operative periods. Combined (external and intracavitary) irradiation was employed in uterine cervix patients whose general somatic condition rendered them inoperable, patients with locally

advanced tumours and those who refused to undergo surgical intervention. The age of the patients ranged from 13 to 79 years. In the combined modality treatment their tumours were staged as follows: stage I, 76 (41%) patients; stage II, 57 (30.8%); stage III, 40 (21.6%); stage IV, 12 (6.5%). For combined radiotherapy the figures were: 7 (9%); 37 (48%); 23 (30%) and 10 (13%) patients for stages I–IV, respectively. RESULTS AND CONCLUSIONS: The 5-year survival rate in the patients administered the combined modality treatment was 76.8 ± 3.1 (stage I, 91.8 ± 3.2; stage II, $78.8 \pm 5.4\%$; stage III, $64.4 \pm 7.7\%$; stage IV, $16.7 \pm 10.8\%$). In the patients who underwent combined irradiation it was $44.4 \pm 5.8\%$ (I, $57.1 \pm 18.7\%$; II, $62.4 \pm 8.3\%$; III, $32 \pm 10\%$; IV, 0%). The data presented indicate that better results were obtained with the combined modality treatment, making it the treatment of choice for acinar forms of uterine cervix carcinoma.

POSTER 1506

Efficiency of combined modality treatment of stage II cervical cancer patients

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PURPOSE: To develop a technique of combined modality treatment of stage II uterine cervix cancer using pre-operative large fraction intracavitary irradiation by means of a hose gamma-therapeutic unit, with the aim of reducing the rate of local tumour recurrence. MATERIALS AND METHODS: We have studied clinical data of 99 stage II cervical cancer patients administered combined modality treatment including pre-operative intracavitary gamma-therapy, Wertheim's operation and post-operative external irradiation of the small pelvis. The patients received pre-operative remote alterloading irradiation of a single dose of 10 Gy and total dose of 20 Gy. The interval between irradiation treatments was 7 days and the time between irradiation completion and surgery was 24–48 h. Intracavitary irradiation before surgery was administered to patients with cervical tumour extending beyond the paracervical triangle or involving not more than the upper third of the vagina. Combined modality treatment was regarded to be indicated for such patients if their cervical cancer was concomitant with uterine myoma, ovarian cystoma or pregnancy. Staging was based on the results of clinical, pathological, lymphographic and other methods of examination. RESULTS: Our study demonstrated that intracavitary gamma-therapy did not hamper the technical performance of surgical intervention, nor did it have any impact on the pattern of intraoperative and post-operative complications. Post-operative mortality was 1.0%. After completion of the treatment, ureter stricture was found in two patients, one patient developed vesicovaginal fistula, five patients had lymphostasis of lower extremities and 17 had post-operative lymphatic cysts. A total of 98 patients was discharged from the hospital. 13 patients died of metastases in lungs, vertebrae or supraclavicular lymph nodes. None of the total number of the cervical cancer patients examined had local tumour recurrence in the vagina stump which is an indication of a proper antiblastic effect of irradiation ensuring the efficacy of surgical intervention. CONCLUSION: The data obtained give reason to conclude that combined modality treatment including pre-operative large fraction intracavitary remote afterloading irradiation, Wertheim's operation and post-operative external irradiation is highly efficient. It is indicated for stage II uterine cervix cancer patients.

Tuesday 2 June

1400–1600
College of Radiographers
Students' Scientific Session
Hall 9

Times to be confirmed.

The Good, the bad and the audit!
S G Holmes and D Porteous
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This presentation will discuss the issues which should be considered in the audit process. Audit seeks to identify areas for improvement to ensure quality is being maintained. Often this means comparing the quality of care actually being delivered with agreed standards. The quality of care may be seen from a variety of perspectives and may be divided into "technical" and "interpersonal" aspects. An important dimension to quality that is not always considered is patient satisfaction. Audit may be hindered by such factors as the negative attitudes of staff and resistance to changes in practice. Unlike research, audit does not require ethical committee approval although it has the potential to encounter problems when dealing with sensitive areas. For a true picture to be gained from the audit process, the audit must be conducted in a way that avoids possible bias. Reliability and validity should be considered when selecting an appropriate tool, when choosing the sampling method and when deciding on the method of collecting data.

The feasibility of ultrasound screening for abdominal aortic aneurysms within a General Practice surgery
A J Tuck
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PURPOSE: If the diameter of an abdominal aortic aneurysm (AAA) reaches 6 cm, the chance of rupture is high. In 1995, 44% of all deaths attributed to aortic aneurysms were caused by rupture. It has been proven that screening for AAAs can reduce the incidence of rupture by providing elective surgery to those with aneurysms of 5–6 cm or greater. Screening programmes run by General Practitioners (GPs) have the advantages of the population involved already being known to the GP, good administrative systems already set up and easy access of patients to GP surgeries. The aim of this research is a cost comparison for AAAs between a screening service in a GP surgery and emergency surgery costs. METHOD: Data were collected by semi-structured interviews. Costs for screening were established from a Hospital Finance Department, a Regional Health Authority and The National Mortality and Population Statistics. Some analysis calculations used results from a previous trial. RESULTS: Screening costs within a GP surgery for all men aged 65–74 years and also for those turning 65 were determined. In both cases the research showed the cost of emergency surgery was less than the cost of a screening programme. CONCLUSION: On a simple cost comparison basis a GP screening programme is not economically viable and, before such a programme could be established, other criteria such as life year values would have to be considered.

Further details of Student Session will be available at Radiology 1998.

Posters

National Indoor Arena Concourse Area

Student

POSTER 1801

Comparing MRI with ultrasound for acute atraumatic hip pain in children

J Boyd

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Conventionally, ultrasound with or without plain radiographs has been used to diagnose acute atraumatic hip pain in children. The diagnostic value of MRI is now being investigated and this study was carried out by the MRI and accident and emergency staff at a paediatric hospital in Edinburgh. 50 children who presented to the Accident and Emergency Department with a painful hip were scanned with ultrasound and X-rayed if required (normal protocol). Then, with parental consent, the children were scanned using MRI within 72 h of presentation. Three specific sequences using the Picker Outlook 0.23 tesla open MR scanner were carried out. As on ultrasound, the MR system ideally demonstrated effusions around the hip joint. However, additional pathologies including muscular infections, femoral capital epiphysis problems and bony abnormalities were also demonstrated using MRI. These were not detected by ultrasound. The observations so far indicate that MRI is a beneficial technique in diagnosing hip pain in children. The study is to be completed in February 1998 and the final results and conclusions will be presented.

POSTER 1802

Assessment of the introduction of an ultrasound co-ordinator

J M Thornton

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At the Victoria Hospital, Kirkcaldy, assessment of the impact of the ultrasound co-ordinator was required. Appraisal was made by: vetting the request cards, examining waiting lists and patient analysing questionnaires. The co-ordinator's role is to sort and appoint the requests to a sonographer's or radiologist's scanning list. For 6 weeks the origin of requests was monitored, ascertaining the number of requests arriving with: correct patient details, inappropriate or inadequate clinical information, doctor's signature or marked required urgently. A retrospective study, 5 days before the introduction of the co-ordinator, to establish: the number of days from referral date to examination date, referral source and scan result. The same data were collected for a week, after the introduction of the co-ordinator, to allow comparison. Quality of the service from the patient's perspective was determined using a structured questionnaire, distributed to 25% of patients comprising the monthly workload. The results showed that patients were happy to wait providing the situation was explained, consultants were less likely to say that an examination was urgent compared with the co-ordinator, the waiting lists had not altered substantially with the introduction of a co-ordinator, there was a decrease in the number of scans with a negative or inconclusive result and there was definite evidence to support the need of a probe for intrauterine scanning. In conclusion, many areas have been highlighted to be considered for future study.

POSTER 1803

An investigation into the diagnostic radiographer's perspective of Continuing Professional Development in Scotland

C Jones

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Following on from the current review of the Professions Supplementary to Medicine Act 1960, it is possible that all healthcare professionals will be statutorily required to participate in Continuing Professional Development (CPD) in order to gain registration with their professional body. This project intends to investigate the diagnostic radiographer's opinion of CPD in Scotland, in order to establish the views and attitudes of radiographers of all grades regarding this very important change in working practice. It essentially seeks to identify the amount of CPD undertaken by working radiographers and what form this takes. The study also aims to identify the perceived barriers to continuing professional development in local departments, and seeks to establish if clinical radiographers believe that CPD actually makes a difference to them in practice? The study involved a representative sample of state registered radiographers in Scotland. One hospital from each of the 13 current health boards in Scotland were asked to participate in this research, resulting in a study sample of 280. The research tool used in this project was a mailed, self-completion questionnaire. Final conclusions will be drawn in April 1998.

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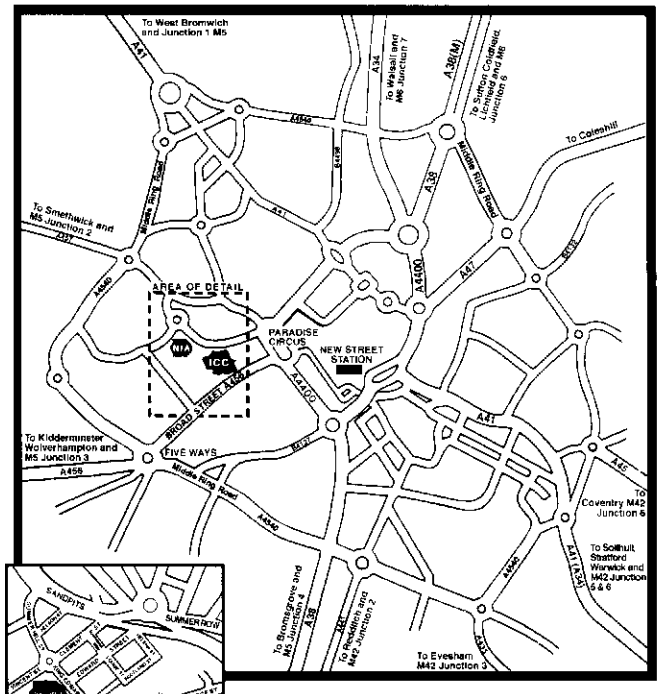

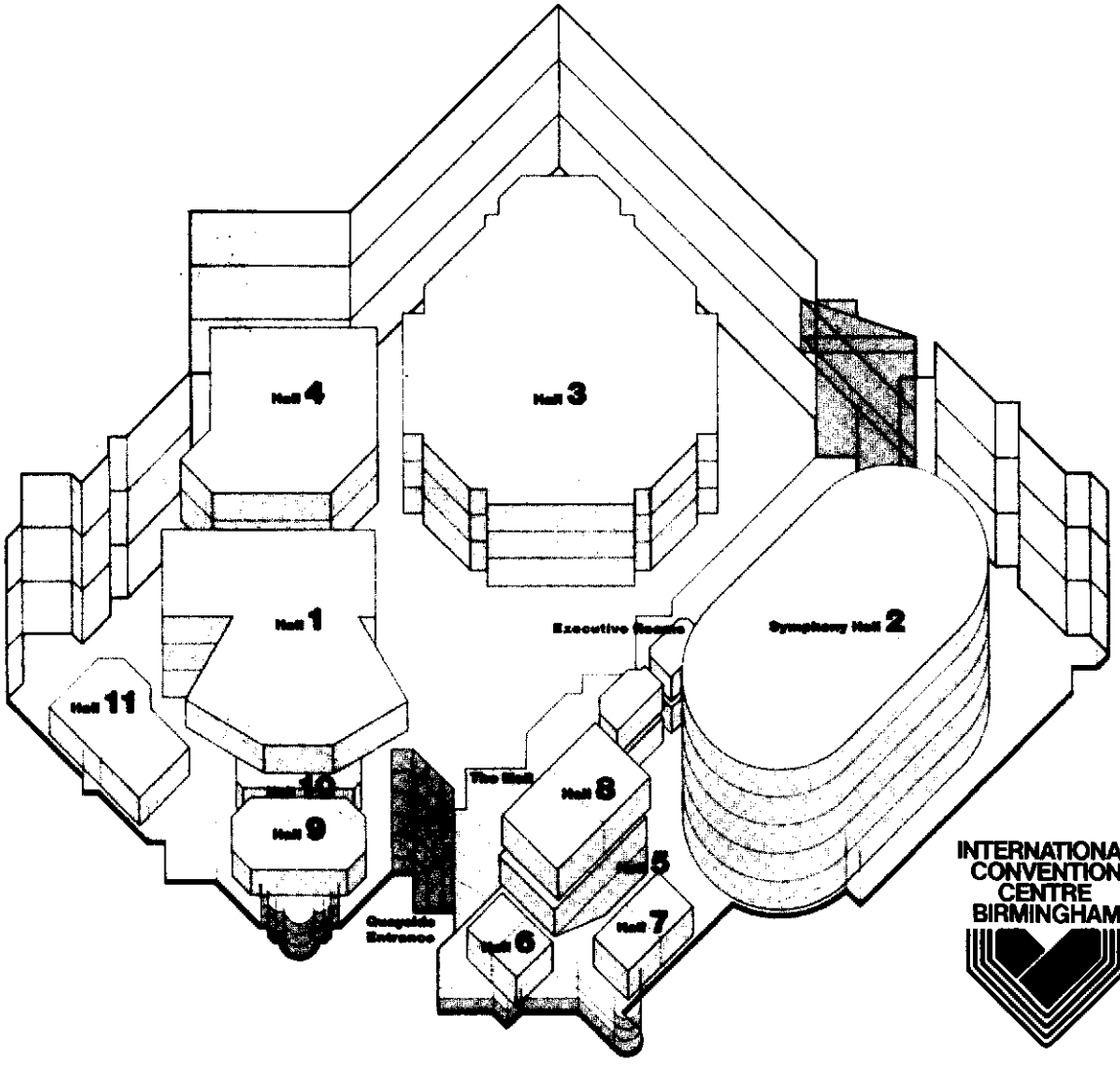

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