Scientific Programme Abstracts

Monday 17 May

0830–1000
State of the Art Symposium
Tuberculosis in the Millennium
Hall 5

0830
Invited Review
Tuberculosis of the chest
S P G Padley
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Tuberculosis is an ancient disease. Modern medicine had made some inroads into reducing the prevalence of this condition with a steady decline in reported cases documented between the early 1950s and the early 1980s. This trend has now reversed with an increased incidence of reported cases in immigrant populations and ethnic minorities. This changing trend is also partly explained by the advent of the HIV epidemic and worldwide TB has emerged as the most common opportunistic infection in patients who die of AIDS. The chest radiograph remains the mainstay of radiological evaluation, with CT being reserved for clarification of unusual appearances, or for the confirmation of questionable abnormalities. The radiographic appearances are varied. Primary TB has traditionally been associated with the paediatric population but is now increasingly encountered in adults, usually as parenchymal consolidation in any pulmonary segment. Features that are suggestive of other than typical bacterial infection include failure of response to therapy and PPD conversion. Although associated lymph node enlargement is almost universal in primary disease in children it is much more variable in the adult population. Miliary disease is most commonly encountered as a complication of primary disease. Post-primary TB usually results in apical upper or superior segment lower lobe cavitation without nodal enlargement. Assessment of disease activity cannot reliably be made on a single chest radiograph. The establishment of stable disease usually requires negative sputum cultures and no radiographic change over 6 months. Pleural disease is usually a complication of primary disease, and is a common presentation in young adults who usually have unilateral large effusions, negative on culture on microscopy, with diagnosis requiring pleural biopsy. This review will detail the most frequently encountered radiographic manifestations of pulmonary TB, and will include a review of TB in the HIV population.

0855
Invited Review
Abdominal tuberculosis
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Abdominal TB is rare, but is occurring with increasing frequency in patients with immunosuppression. TB should also be considered in recent immigrants from Asia, Africa, and Eastern Europe. In addition, Mycobacterium avium-intracellulare (MAI) is frequently the responsible organism. In HIV disease extrapulmonary involvement occurs in up to 70% of patients, with a significant proportion involving abdominal sites. 90% of GIT MTB involves the ileocaecal region. Barium studies show ulceration, thickening of the ileocaecal valve, narrowing of the terminal ileum (Fleischner sign), and a conical shrunken caecum (Stierlin's sign). CT demonstrates circumferential bowel wall thickening with adjacent mesenteric lymphadenopathy, which may have central areas of reduced attenuation indicating caseous necrosis. MTB of the liver and spleen is common at autopsy but is not usually seen at the initial presentation. It may occur in AIDS presenting with hepatosplenomegaly and occasionally tiny low density foci. TB peritonitis occurs in less than 4% of patients but is more common in immunosuppressed patients. The "wet" type (90%) is characterized by ascites which on CT has high attenuation, reflecting high protein and cellular content. The "fibrotic-fixed" type (60%) is characterized by large omental masses and matted loops of bowel. The "dry" type (10%) is characterized by caseous nodules, fibrous peritoneal reaction and dense adhesions. MAI infection is common in AIDS patients, diagnosed in as many as 25–50% of cases during life or at autopsy. Infection tends to occur in the later stage of AIDS, when immune deficiency is severe. Evaluation with CT may distinguish MTB and MAI infection. Moderate or marked hepatosplenomegaly makes the diagnosis more likely to be MAI than MTB. Enlarged lymphadenopathy is seen with both but in MTB central caseous necrosis is more common than in MAI.

0920
Invited Review
TB in the Millennium: spinal and skeletal manifestations
R W Kerslake
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Plain films and magnetic resonance imaging are of particular benefit in the investigation of spinal and skeletal tuberculous disease. Approaches to diagnosis and management will be discussed.

0945
Discussion

0830–0950
Scientific Session
Genitourinary Imaging
Hall 8

0830
Invited Review
Imaging in haematuria
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The evaluation of haematuria is made difficult by the multiplicity of possible causes. As well as urinary tract malignancy, haematuria may be caused by stone disease, urinary tract infection, benign prostatic enlargement, glomerulonephritis and a variety of other nephrological conditions. Traditionally, haematuria was investigated by urography for the upper tracts and cystoscopy for the bladder. The question arises as to whether ultrasound and plain films could replace the urogram. The available literature indicates that neither method is ideal. Ultrasound detects renal masses and bladder tumours better, but urography is better at diagnosing stone disease, upper tract transitional cell tumours and other urothelial abnormalities. Imaging protocols in haematuria should therefore involve both methods, used either together or in sequence, to maximize detection of significant pathology. In selected patients, computed tomography and/or angiography may also be necessary. The causes of microscopic haematuria are identical to those of macroscopic haematuria, although the frequency of the different conditions is lower. The imaging protocol for both types of haematuria should therefore be the same, apart from in young patients. Under the age of 30 the risk of malignancy is low and ultrasound and plain films may be chosen to evaluate microscopic haematuria. This strategy will, however, miss some patients with urinary tract stone disease.

0900
Spiral CT angiography in the assessment of renal artery stenosis: which post-processing method to use?
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PURPOSE: The aim of the study was to evaluate spiral CT angiography (CTA) in the diagnosis of renal artery stenosis, and to investigate which methods of data post-processing were the most efficient and accurate in diagnosing the presence and degree of stenoses. METHODS: 20 consecutive patients referred for investigation of suspected renal artery stenosis underwent CTA and then digitally subtracted angiography (DSA). The CT data were examined on a workstation as axial images, multiplanar reformats (MPR) and three-dimensional surface shaded display (SSD) models. The SSD models were also viewed internally with virtual angioscopy software. RESULTS: The most accurate method of assessing the data was found to be a combination of axial images and MPR. If the proximal renal arteries were tortuous, then curved MPR was useful. This method yielded a sensitivity of 91% and a specificity of 93% in the detection of significant (>50%) stenoses as compared with the gold standard of DSA. SSD models rarely increased the accuracy of CTA, and the process of making the models was extremely user dependent. Virtual angioscopy was not helpful in any of the cases, the degree of stenosis being universally easier to assess from external views. CONCLUSION: Spiral CTA can detect and quantify renal

artery stenoses with a high degree of accuracy. Assessment of axial images and MPRs provides sufficient diagnostic information; further processing to form SSD models and virtual angioscopic displays adds little to the accuracy, and is both time consuming and very user dependent.

0910

Accuracy of visualization of renal arterial anatomy and stenosis using gadolinium enhanced MR angiography

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PURPOSE: To determine the accuracy of gadolinium-enhanced magnetic angiography (MRA) in the visualization of renal arterial anatomy and detecting stenosis as compared with digital subtraction angiography (DSA). MATERIALS AND METHODS: 12 potential renal donors and 24 hypertensive patients suspected of having renal artery stenosis, all of whom were scheduled to undergo elective DSA, were prospectively studied. Gadolinium-enhanced MRA was performed on an 1.5T MR scanner using an enhanced 3D fast gradient echo (efgre3D) sequence which enables acquisition of a volume data set with a breath hold of 23 s after injection of gadolinium intravenously. The delay is calculated using a test dose of gadolinium. The potential renal donors also underwent MR urography using a single shot fast spin echo sequence (SSFSE). The MR renal angiograms and DSA studies were separately evaluated by two consultant radiologists. RESULTS: One MR angiogram was inconclusive owing to the patient's inability to hold their breath, one patient was claustrophobic, while in three more patients venous enhancement prevented assessment on the MIP images but was possible from the source images. Thus except for the first two patients MR angiography could visualize 82 of the 84 arteries. MR angiography enabled correct diagnosis of grade 2 stenosis (50%–99%) in 19 out of 20 arteries and of all the four occluded arteries. Sensitivity and specificity for correct identification of a grade 2 stenosis were 98% and 94% respectively. CONCLUSION: Gadolinium-enhanced MRA is an accurate, non-invasive method for assessment of renal arterial anatomy and detecting stenosis and can thus replace DSA for diagnostic purposes in future.

0920

Urological surveillance in patients with spinal dysraphism: the value of MR urography

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PURPOSE: In patients with spinal dysraphism (SD), intravenous urography (IVU) is often difficult and the need for follow-up studies results in high cumulative radiation dose. The aim of this study was to evaluate the role of MR urography (MRU) in the radiological assessment of the urinary tract in patients with SD. MATERIALS AND METHODS: 14 patients (males ($n=7$), females ($n=7$)) with SD were referred for MRU using HASTE and RARE sequences on a 1.5T machine. Six patients did not tolerate MRU owing to claustrophobia ($n=4$) or flexion deformities ($n=2$). Images were assessed by two radiologists and compared with previous IVU studies. RESULTS: Two patients had a single kidney (nephrectomy ($n=1$), crossed fused ectopia ($n=1$)). Visualization of renal parenchyma and pelvicalyceal systems was better with HASTE than with RARE while visualization of the ureters and bladder was comparable for both sequences. 12 of the 14 kidneys had calyceal clubbing and four kidneys had renal parenchymal scarring. Cortical scarring was better seen on MRU than IVU, whereas a renal calculus seen on IVU was not visualized on MRU. CONCLUSION: MRU is a safe and accurate method of evaluating the urinary tract in patients with SD and avoids radiation dose and possible renal impairment associated with intravenous contrast.

0930

Ureteral strictures in renal transplants — management by antegrade balloon dilatation and temporary internal stenting

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PURPOSE: To evaluate the efficacy of the treatment of transplant ureteral strictures by percutaneous balloon dilatation and temporary internal stenting. MATERIALS AND METHODS: 12 patients who presented with obstructed renal transplants between 1992 and 1998 were treated by antegrade nephrostomy insertion. The site of obstruction was at the pelvi-ureteric junction in one patient and at/near the ureterovesical junction in 11 patients. Ureteroplasty and internal stenting was performed between 3 and 18 days (mean 10.4 days) following nephrostomy. Stents were removed transvesically with follow-up clinically by serial serum creatinine and radiologically by sonography +/− scintigraphy. Patients were divided into two groups for analysis: obstruction within 3 months of transplantation (group A) and obstruction more than 3 months after transplantation (group B). RESULTS: All procedures were technically successful with no immediate complications. In group A ($n=9$), two patients required one further balloon dilatation with stenting owing to stricture recurrence and two recently treated patients are still stented–not included in current analysis. In group B ($n=3$), one patient developed stricture recurrence despite repeated balloon dilatation and re-operation. Stents were removed successfully in nine patients between 28 and 195 days (mean 89.7 days) post initial insertion with a follow-up interval of 1–65 months (mean 20.5 months). Treatment was successful for all patients in group A (100%) and two patients in group B (66%), with an overall success rate of 90%. CONCLUSION: Balloon dilatation and internal stenting is a useful method for treating early ureteral strictures, and may avoid the need for re-operation in most cases.

0940

Prevalence and practice regarding testicular microlithiasis in a symptomatic population referred for scrotal ultrasound

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PURPOSE: Testicular microlithiasis (TML) has a typical sonographic appearance with bilateral diffuse non-shadowing hyperechoic foci within the testicular parenchyma. There is increasingly well documented evidence of an association between TML, intratubular germ cell neoplasia, concurrent and possibly subsequent development of testicular neoplasm. A retrospective assessment of the prevalence and subsequent management of TML in a symptomatic scrotal ultrasound population was undertaken. METHOD: A computerized keyword search for "TML, testicular microliths and calcification" over a 30 month period (April 1996 to September 1998) yielded 18 cases of TML from 2748 scrotal studies. The reports and images were analysed and if these met the criteria for TML the patient records were obtained. RESULTS: The prevalence of TML was 0.66% (18/2748), with 17/18 being bilateral and 1/18 being unilateral. The mean age for the TML cases was 34.3 years (range 14–53). There was one case (1/18) of concurrent testicular tumour at time of diagnosis. There were 36 sonographically evident tumours in the non-TML population during this period. To date no metachronous tumours have been noted in the TML patient group. 8/18 cases are currently under specific sonographic follow-up at 6-monthly intervals. However, owing to variable practice 10/18 cases are not under active follow-up. CONCLUSION: In this study group TML had a prevalence of 0.66%. Only 1/18 cases demonstrated concurrent tumour at time of diagnosis of TML. Audit highlighted very variable practice with regard to patient follow-up. In view of current evidence these patients are being recalled to exclude metachronous tumour.

0830–1030
Scientific Session
New Views on Gastrointestinal Investigation
Hall 11A

0830

Invited Review

Ultrasound of the stomach and duodenum

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Sonography may be used for the detection and staging of diseases of the stomach and duodenum. Large gastric tumours, either adenocarcinoma, lymphoma or leiomyosarcoma, can be detected incidentally in patients complaining of non-specific abdominal symptoms such as indigestion or abdominal discomfort. Stomach cancers, once detected by endoscopy or upper gastrointestinal series, can be staged by transabdominal sonography. The accuracy of T stage is around 70–80%. Liver metastasis can be fairly accurately

determined, the accuracy being 80–90%, but lymph node metastasis is difficult to evaluate by sonography. Peritoneal miliary seeding is also difficult by sonography, even though a small amount of ascites or ovarian metastasis can be detected in the early stage. Duodenal ulcers are mostly diagnosed by endoscopy or upper gastrointestinal series. Sometimes, duodenal ulcers can be detected by sonography in patients with an acute abdomen resulting from ulcer perforation. A combination of duodenal wall thickening, a small defect in the thickened wall, and a small amount of subphrenic air may lead to a diagnosis of perforated duodenal ulcer. Stenosis or obstruction of the duodenal loop by cancer, inflammatory stricture, or congenital malformation can be detected by identifying the dilated duodenal loop and stenotic segment. The lack of bowel gas due to duodenal obstruction makes sonography easy. Traumatic duodenal wall haemorrhage can be diagnosed easily. Sonography is the procedure of choice in the diagnosis of afferent loop syndrome. By and large, sonography plays a complementary role in the diagnosis of diseases of the stomach and duodenum, but in some circumstances, such as for the diagnosis of extragastric metastasis of a stomach cancer, duodenal obstruction including afferent loop syndrome and duodenal haematoma, sonography may be used as the procedure of primary investigation.

0900

Unenhanced spiral CT for evaluating acute appendicitis

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PURPOSE: The purpose of this study was to define the role of focused CT in adult patients with suspected acute appendicitis and to determine the effect of CT on the treatment of such patients. MATERIALS AND METHODS: Appendiceal CT was performed in 120 consecutive patients with acute appendicitis in the differential diagnosis, whose clinical findings were insufficient to perform surgery or to discharge them from the hospital. Each scan was obtained in a single breath-hold from the lower abdomen to the upper pelvis using a 5 mm collimation and a pitch of 1.6. No patients were given oral or intravenous contrast media. CT results were correlated with surgical and pathologic findings at appendectomy or clinical follow-up. RESULTS: 88 of the 93 patients with acute appendicitis were correctly diagnosed by CT, 24 of the 27 patients without acute appendicitis were correctly diagnosed by CT (95% sensitivity, 89% specificity). CT signs of acute appendicitis included fat stranding (100%), enlarged appendix (>6 mm) (97%), adenopathy (63%), appendicoliths (43%), abscess (10%), and phlegmon (5%). CONCLUSION: An enlarged appendix with periappendiceal fat stranding is by far the most common CT finding in acute appendicitis. The use of spiral CT in patients with equivocal clinical presentation suspected of having acute appendicitis led to a significant improvement in the preoperative diagnosis and a lower negative appendectomy rate. Routine use of focused appendiceal CT may lower the costs of caring for patients with clinically suspected appendicitis.

0910

Diagnostic management of the acute abdomen: unenhanced spiral CT abdominal plain radiography and sonography

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PURPOSE: To assess the utility of spiral CT in patients with acute abdominal pain in comparison with abdominal plain film and sonography and to evaluate the role of unenhanced spiral CT in the diagnostic management of the acute abdomen. MATERIALS AND METHODS: 144 patients with acute abdominal pain were investigated by spiral CT and plain abdominal film and/or sonography of the abdomen. In patients with an unenhanced CT, two radiologists evaluated whether a correct diagnosis can also be made without a contrast agent. We reviewed the diagnoses made in CT, abdominal plain film and sonography and calculated the sensitivity. The diagnoses were verified either histologically or by follow-up of the disease. RESULTS: In 89% of acute inflammatory diseases such as cholecystitis, pancreatitis and diverticulitis and in 72% of tumours unenhanced spiral CT is sufficient. We can also detect ureterolithiasis without injection of contrast material. In patients with vascular diseases and in renal and spleen diseases except nephrolithiasis enhanced CT is necessary. The accuracy of CT was 90%, that of abdominal plain radiography was 46% and that of sonography was 62%. CONCLUSION: Spiral CT is more accurate than sonography and abdominal plain radiography in differentiating the cause of acute abdominal pain. With abdominal plain radiography the exact cause of the pain can rarely be indicated. Unenhanced spiral CT should be the first diagnostic modality in the diagnostic management of the acute abdomen in the acute phase. Contrast agents are unnecessary for differentiation of the acute abdomen if unenhanced spiral CT shows the cause of the acute complaints.

0920

Helical CT of the small bowel with an alternative oral contrast material in patients with inflammatory bowel disease

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PURPOSE: To assess the value and usefulness of helical CT with a negative oral contrast material evaluating inflammatory bowel disease. MATERIAL AND METHODS: 31 patients with proven inflammatory bowel disease (IBD) (28 Crohn's disease, 3 other) were studied prospectively. The examination started with administration of a large volume (≥1500 ml) of oral negative contrast material (Mucofalk® water suspension) followed by helical CT scanning. Our standard imaging parameters were 5 mm collimation at 7.5 mm table feet and reconstruction interval 3 or 4 mm. 120 ml non-ionic contrast material was delivered automatically (flow rate 3 ml s^{-1}) with a delay of 25 s. CT findings were correlated with conventional radiography in 22 cases, and two patients obtained complementary MRI. A score for small bowel distension was created (good, moderate, poor). RESULTS: Good small bowel distension, which is necessary to provide diagnostic error, could be achieved in 20 patients (64.5%). 26 of 31 patients had CT findings of IBD; 19 of these 26 patients underwent conventional radiography. All diagnoses were confirmed at endoscopy and histology. CONCLUSION: Mucofalk® CT is a comfortable non-invasive alternative method with the potential of demonstrating inflammatory disease of the small bowel.

0930

Outcome for patients with suspected perianal fistula but negative MR imaging

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PURPOSE: The value of MR imaging in excluding fistulous disease and establishing alternative perineal diagnoses is uncertain. We describe the outcome for patients in whom MR imaging did not make a definite diagnosis of fistulation. METHODS: All patients had MR imaging with a body coil to an identical protocol. All studies were classified by the same experienced observer. 54 "negative" examinations were identified over a 4 year period and divided into three categories: (i) normal study; (ii) abnormal enhancement or other signal abnormality in the perianal region without definite fistula or abscess; (iii) alternative diagnosis. Eventual diagnoses were established by case note review in 35 of the 54 cases. RESULTS: MR categories for the 35 cases were: (i) normal study (6), of whom none was subsequently shown to have fistulae; (ii) abnormal (14), of whom 6 had fistulae; (iii) alternative diagnoses (15), of whom 3 subsequently had fistulae. For 9 of the 35 patients the eventual surgical diagnosis was fistula, a negative predictive value for MR imaging of 74%. For the 15 alternative diagnoses, 10 were confirmed and in 2 the diagnosis remained uncertain. For this group and those with normal studies only 3 fistulae were diagnosed during follow-up, a negative predictive value of 86%. CONCLUSION: When MR imaging allows an alternative diagnosis or is normal there is a high exclusion value for fistula. When there is abnormal enhancement and/or other signal abnormality in and around the anal canal the likelihood of fistulation is more than 1 in 3 even when a definite fistula is not apparent. One third of patients with "negative" MR imaging were lost to follow-up.

0940

Imaging the incontinent anal sphincter: endoanal MR imaging or endosonography?

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PURPOSE: Anal endosonography (AES) is the accepted gold standard for characterization of sphincter damage in incontinent patients. However, it requires dedicated equipment and considerable expertise. The introduction of endoanal MR coils may provide a more accurate and readily available alternative. This prospective, blind study compared each technique, arbitrated by history, examination and anorectal physiological testing. METHODS: 45 consecutive adult patients complaining of anal incontinence were recruited.

After a detailed clinical history, examination and full anorectal physiological testing, subjects were examined by both AES and MR on the same day by two consultant radiologists, blinded to each other's findings: AES was performed using a 10 MHz probe (B&K, 6004) and T_2-weighted MR imaging used a Philips endoanal receiver coil and static 1.0T magnet. AES and MR were compared to determine agreement for internal (IAS) and external (EAS) sphincter defects. RESULTS: Both AES and MR imaging agreed in 28 patients (62%): 18 with intact sphincters; 7 combined EAS and IAS defects; 1 isolated IAS defect; 2 isolated EAS defects. MR was incorrect in 14 patients (31%): 8 with isolated IAS defects; 4 with isolated EAS tears, and diagnosed tears in 2 subjects with normal sphincters. AES was incorrect in 3 subjects (7%), falsely diagnosing an EAS tear in 2 subjects and failing to diagnose an EAS tear in a third. CONCLUSION: This study found that endoanal MR imaging correctly determined sphincter morphology in 31 (69%) subjects compared with 42 (93%) by endosonography, findings at odds with preliminary reports supporting endoanal MR. The major disadvantage of MR relates to insensitivity for isolated internal sphincter damage.

0950

Dynamic MR imaging of the pelvic floor in asymptomatic subjects

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PURPOSE: Dynamic MR imaging may be used to evaluate pelvic floor configuration and movement in patients complaining of urinary and faecal incontinence, and constipation, possibly displacing tests such as cystoproctography. However, apparently abnormal proctographic findings have been found in asymptomatic individuals and to date no such study has been performed using MR. This prospective study aimed to determine the range of dynamic MR appearances in asymptomatic subjects. METHODS: 30 asymptomatic volunteers (mean age 31 years, range 22–63, 14 male) have been examined to date. Subjects were volunteers or were recruited from those attending for lumbar spine examination. All denied functional pelvic symptoms and were established as normal using a verified questionnaire. Subjects underwent dynamic axial, coronal and sagittal MR at rest and during maximal pelvic strain using a static 1.0T unit and fast field echo sequences, providing 10 slices in 31 s. Standardized measurements of pelvic configuration were taken and rest/strain scans compared to determine the range of normal appearances. RESULTS: Mean bladder descent on straining was 0.6 cm (SD 0.6), mean uterocervical descent was 1.0 cm (SD 0.8) and mean anorectal junction descent was 1.0 cm (SD 0.9). Mean anorectal angle did not alter: 100° (SD 13°). The pelvic floor hiatus (mean difference +6.6 cm^2) and perimeter (mean difference +1.8 cm) both increased on straining. Cystocoele, enterocoele, perineal hernia or rectal prolapse were not seen. CONCLUSION: The normal range of pelvic organ descent in asymptomatic subjects has been defined, and is broadly in agreement with that obtained from dynamic cystoproctography. No volunteer demonstrated any prolapse syndrome.

1000

Percutaneous core biopsy of lesions of the gastrointestinal tract

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INTRODUCTION: Percutaneous core biopsy of lesions of the gastrointestinal (GI) tract can provide accurate tissue diagnosis prior to surgery when conventional endoscopic biopsies have failed or the lesion is inaccessible. We present our experience of 16 biopsies carried out over a 4 year period. METHOD: 16 biopsy procedures were carried out on 13 patients with suspected intra-abdominal malignancy following abnormal barium studies or CT, when endoscopic biopsy had failed or the lesion was inaccessible. Standard biopsy techniques were employed using an 18G Temno biopsy needle. The solid component of the bowel mass was biopsied using a route that did not transgress the bowel lumen. RESULTS: Three biopsies were inadequate and needed repeating, giving a total of 16 biopsy procedures. Three samples were obtained from the stomach, three from the duodenum, five from the small bowel and five from the large bowel. A tissue diagnosis was made in all 13 patients. There were no immediate or delayed complications, and all procedures were well tolerated. CONCLUSION: Percutaneous biopsy of bowel masses is a safe technique that allows a histological diagnosis to be obtained in difficult cases.

1010

The changing role of mesenteric angiography in the management of gastrointestinal haemorrhage: an audit of the past 10 years

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PURPOSE: To assess if there are changing patterns of referral and outcome in mesenteric angiography for gastrointestinal haemorrhage over the past 10 years. METHOD: All the mesenteric angiograms performed in a teaching hospital over the past 10 years were reviewed. From this initial group all the angiograms performed for acute gastrointestinal haemorrhage were identified. The patient's age, sex and method of referral were noted together with the endoscopy results, initial laboratory findings and other investigations such as a radio-isotope red cell scan. The results of the angiogram were correlated to the clinical outcomes, including the surgical outcome if operative intervention was performed. RESULTS: Over the last 10 years, 100 mesenteric angiograms have been performed for investigation of gastrointestinal haemorrhage. There has been little change in the number of investigations per year with a mean of 14, range 9 24. Forty-five were performed in females and the mean patient age was 56 years. A positive angiographic diagnosis was obtained in 32 cases. A radioisotope labelled red cell scan was performed in 18 cases and was positive in 12 cases. However, in only 2 patients was the angiogram positive in identifying haemorrhage. In no case was the isotope scan negative and the angiogram positive. CONCLUSION: The referral for mesenteric angiograms over the past 10 years has remained constant in our centre. A positive diagnosis was obtained in 32% of patients.

1020

Gastrointestinal bleed scintigraphy can help when other imaging fails

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AIM: To increase awareness of the pitfalls of arteriography, upper endoscopy and colonoscopy in the investigation of gastrointestinal (GI) haemorrhage and to show when $^{99}Tc^m$-RBC scintigraphy is helpful. METHODS: Six consecutive patients were studied. Presenting symptoms were: diarrhoea and anaemia (3), fresh PR bleeding (3), melaena (2). All had upper endoscopy and colonoscopy. Selective mesenteric arteriography was performed prior to $^{99}Tc^m$-RBC scintigraphy in 5/6 cases. 750 MBq of $^{99}Tc^m$ pertechnetate after injection of stannous pyrophosphate were administered. Images were acquired dynamically for 40 min with static images at 1, 3, 6 and occasionally 24 h. RESULTS: $^{99}Tc^m$-RBC scintigraphy correctly showed the source of active bleeding in 5/6 cases, which was missed by the conventional investigations in 4/6 patients. The pitfalls of the other techniques highlighted by $^{99}Tc^m$-RBC scan were: short time span for imaging of arteriography (2); inferior mesenteric artery difficult to catheterize in atherosclerotic disease (1); endoscopy less sensitive in detecting oesophageal varices (1). One study highlighted the best use of a positive $^{99}Tc^m$-RBC scan: to direct subsequent selective arteriography. Causes of GI bleed were: colonic polyp (1), angiodysplasia (3), oesophageal varices (1), jejunal malignant stromal tumour (1). CONCLUSION: $^{99}Tc^m$-RBC scintigraphy, currently underutilized, plays an important role in the investigation of GI haemorrhage; in our experience, its best use is prior to arteriography if the patient is stable.

0830–1015
State of the Art Symposium
Progress in Positron Imaging
Hall 11B

0830

Invited Review

Overview of positron emission tomography and its clinical benefits

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Positron emission tomography (PET) has been a powerful tool with which to conduct basic and clinical research for many years. Recently its important role in clinical diagnosis and management

of patients has been recognized, providing qualitative and quantitative information in oncology, cardiology, infectious diseases and neurology. The most commonly used tracers include ^{18}F-fluorodeoxyglucose (FDG), ^{11}C-methionine, ^{13}N-ammonia, ^{15}O-water and ^{11}C-flumazenil. The management of solid tumours is dependent on accurate and effective staging procedures which commonly employ one or more imaging methods. PET imaging is potentially able to locate and stage tumours with one diagnostic test. The cost effectiveness of PET has been demonstrated in lung cancer, and the effects on patient management have been shown in lymphoma and other tumours, *e.g.* germ cell, gut and head and neck. The utility of early imaging post-therapy may be useful in assessing disease response. The optimum timing of scans, however, still needs to be realized. Clinical cardiac PET imaging is primarily concerned with the question of myocardial viability. Flow tracers, *e.g.* ^{13}N-ammonia, ^{15}O-water and ^{62}Cu-PTSM, can be used to give a qualitative evaluation of flow or a quantitative evaluation. If this is compared with FDG uptake, the presence of viable myocardium can be confirmed. More recently, gated FDG scans can be used to assess wall motion and thickening of the myocardial wall to assess viability in the hypokinetic myocardium. Clinical neurological PET imaging techniques are useful in the assessment of malignancy (tumour grade, tumour recurrence and tumour extent), epileptic foci (lateralization using FDG and ^{11}C-flumazenil) and dementia. Full ring PET cameras have the capability of providing both regional images and whole body images with or without quantitation if combined with transmission scanning. The developments occurring at present are related to expanding the field of view, the development of 3D imaging and moves to develop PET gamma cameras (operating in a dual coincidence mode). These developments need careful assessment to determine the role the various modalities will have in different disease processes and the short half-life tracers. What is clear is that clinical PET is here to stay.

0855
Invited Review
Positron emitting radionuclides and radiopharmaceuticals for PET imaging: current status and future developments
J Zweit
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Positron emission tomography (PET) is an *in vivo* imaging technique which provides quantitative information that reflects functional activity of cells within tissues. By using a variety of radiolabelled substances, functional parameters such as blood flow, metabolism and protein synthesis can be measured by PET in normal and diseased tissues. In oncology, PET is currently being used for monitoring response to cancer therapy and for studying the pharmacokinetics of anti-cancer drugs. The uniqueness of PET rests on its unrivalled sensitivity and specificity for measuring low concentrations of molecules in the form of radiotracers and radioligands. This is due to the coincidence detection principle used, and the specificity offered by labelling organic molecules with positron-emitting radionuclides such as ^{11}C ($t_{1/2}$ = 20 min) and ^{18}F ($t_{1/2}$ = 110 min). The advantages of sensitivity and specificity coupled with the use of a number of positron-emitting radionuclides as labels for a variety of substances makes PET a unique modality for imaging and quantifying *in vivo* biochemistry. PET imaging evolved from the use of the short-lived organic radionuclides, ^{15}O ($t_{1/2}$ = 2 min), ^{13}N ($t_{1/2}$ = 10 min) and ^{11}C ($t_{1/2}$ = 20 min) which require the availability of an in-house cyclotron for their production. A number of PET radiopharmaceuticals have been based on these organic radionuclides. These include $H_2{}^{15}O$, $^{15}CO_2$ (blood flow), ^{15}CO (blood volume), $^{13}NH_3$ (blood flow), ^{11}C-acetate (oxygen consumption), ^{11}C-methionine (protein synthesis), ^{11}C-raclopride, ^{11}C-methylspiperone (D2 receptors) and many other ^{11}C-based radiotracers and radioligands currently undergoing clinical PET research in neuroscience, oncology and cardiology. The vast majority of clinical PET however, has been carried out using the glucose analogue 2-fluro-2-deoxy-D-glucose (FDG) labelled with ^{18}F. This metabolic marker still represents the "work-horse" of clinical PET and is used to assess the glycolytic activity of normal and diseased tissues including tumours. The widespread use of ^{18}FDG PET is due to: (i) broad clinical applicability of the radiotracer, (ii) established and commercially available radiosynthesis "know how" and (iii) accessibility through regional distribution afforded by the 110 min half-life. Other ^{18}F-based radiotracers and radioligands currently used in clinical PET research include anti-cancer drugs, amino acids, dopamine transporters and hypoxia markers. A new area in PET science is evolving around the development of radiotracers and radioligands based on medium half-life (1–100 h) radionuclides such as ^{64}Cu ($t_{1/2}$ = 13 h), ^{76}Br ($t_{1/2}$ = 16 h) and ^{124}I ($t_{1/2}$ = 100 h). The longer half-life of these radionuclides allows the use of PET in applications that are characterized by prolonged kinetics such as pharmacokinetics of anti-cancer drugs, peptide, immune and gene therapeutics and chemokines and cytokines which are implicated in many biochemical processes. Development in this area would allow PET to expand its powerful capabilities to probe, *in vivo*, biochemical pathways underlying disease processes. Along with ^{18}F, the inorganic radionuclides could be available from regional distribution centres, an approach that could make PET more widely available and more cost-effective. Future developments in PET radiotracers and radioligands that visualize and quantify *in vivo* biochemistry provide a glimpse at a patient's "chemotype" and PET molecular imaging enables us to connect genotype to phenotype via chemotype.

0910
Invited Review
PET instrumentation — what is available
P H Jarritt
Institute of Nuclear Medicine, Royal Free and University College Medical School, London W1N 8AA, UK

This presentation will review the current status of coincidence imaging systems for clinical diagnosis. Small discrete detectors in coincidence with each other still form the basis of the highest performance PET detectors. These are often referred to as "full ring" systems. These are capable of operation in both 2D and 3D modes. In 2D mode all systems permit quantitative studies with measured attenuation and scatter correction. 3D studies provide enhanced sensitivity and axial resolution but attenuation and scatter correction continue to present technical difficulties for many applications. These systems have been developed in "partial ring" configurations as a means of reducing the number of discrete detectors and therefore cost. Advances in detector technology have resulted in renewed interest in the use of uncollimated multidetector gamma camera systems in coincidence mode. These systems are characterized by significantly lower count rate capability than full ring systems with very high random and scatter coincidence rates but comparable spatial resolution. These systems are inherently 3D in their detection geometry, and attenuation and scatter correction remain difficult issues. Systems for the measurement of attenuation coefficients are being developed for use with Auger gamma camera based systems. Methods for the characterization and assessment of PET systems will be briefly reviewed. The concept of a combined SPECT/PET/CT scanner is leading to significant development of new detector technologies. New scintillators are being combined in an attempt to provide quantitative imaging with radiopharmaceuticals labelled with positron and single photon emitters.

0930
Invited Review
Optimizing the performance of gamma camera PET and 511 keV SPECT systems
T D Fryer
Wolfson Brain Imaging Centre, University of Cambridge, Cambridge CB2 2QQ, UK

In recent years there has been renewed interest in imaging positron emitters using gamma cameras. The radiopharmaceutical of interest has almost exclusively been ^{18}F-fluorodeoxyglucose (FDG) owing to its half-life (110 min), which facilitates imaging remote from a cyclotron, and its diagnostic value in oncology, cardiology and neurology. Two imaging modes are available: 511 keV SPECT using high energy collimators and PET using coincidence electronics. This presentation will discuss the fundamental differences between 511 keV SPECT and PET imaging with a gamma camera, before outlining the acceptance/performance tests applicable in each case. The talk concludes by looking at how the data acquisition stage of both 511 keV SPECT and PET can be optimized, taking into account the image reconstruction software utilized.

0945
Invited Review
A clinical role for positron imaging in cardiology
U M Sivananthan
Yorkshire Heart Centre, Leeds General Infirmary, Great George Street, Leeds LS1 3EX, UK

Positron emission tomography (PET) can determine myocardial viability and decisively influence patient management. Like conventional radionuclide tomography (SPECT), PET displays the regional distribution of tracers in the myocardium in the form of high contrast cross-sectional images. However, unlike both single photon planar and SPECT imaging, PET images depict actual tissue concentrations of radionuclides so that they can be quantified non-invasively. Despite a relatively limited number of clinical studies

with cardiac PET, it is already clear that considerable and often unique insights into pathophysiological processes can be obtained with this imaging modality. At the same time a number of clinical observations in patients with coronary artery disease have direct practical clinical applicability that has the potential to influence patient management decisively. Other studies have made purely descriptive observations. Nevertheless, such studies provide a framework and initial insight to the mechanism that future, more definitive studies can explore. The recent emergence of new tools and probes, such as the ability to assess cardiac pre- and post-synoptic activity, amino acid metabolism and protein synthesis have expanded the armamentarium that is now available to allow improved exploration and quantification of normal and abnormal functional processes involving the heart.

1000
Discussion

0830–0930
Special Focus Session
CiRiS
Olympian Suite

0830
Continuous Improvement for Radiological Imaging Services
E P H Torrie
X-Ray Department, Royal Berkshire Hospital, Reading RG1 5AN, UK
For 2 years The Royal College of Radiologists and The College of Radiographers have been developing jointly a software tool which encourages, objectively measures and benchmarks continuous improvement in the clinical imaging environment. The first generation software has been recently piloted in 13 hospitals. The outcomes of the evaluation form the basis of this presentation, which will also describe ongoing development and the value CiRiS may bring to hard pressed clinical services. CiRiS meets the aspirations of the recent NHS White Papers, in particular with regard to the implications of clinical governance. It is designed to enhance patient care through a process of self-directed continuous improvement. CiRiS is deceptively simple software that helps the clinical service to assess and plan improvements to all areas within its remit. Change is directed by the clinical service, not by a governing body or other agent. Services using CiRiS are challenged in two broad respects: the first being to meet or exceed compulsory and advisory standards and the second to adopt a process of continuing improvement using self-set standards. CiRiS is unique in the latter respect. CiRiS provides objective and irrefutable measures of service improvement. It offers a benchmarking facility, access to sources of reference, latest information and examples of best practice with regular updates to maintain the drive for continuous improvement. It is expected that CiRiS will link with CPD, CME and staff appraisal programmes to provide a comprehensive approach to quality improvement. This presentation will review progress to date, including evaluation outcomes, and will demonstrate the tool in its latest stage of development.

0945–1145
State of the Art Symposium
Whither Film and DR?
Olympian Suite

0945
Invited Review
DirectRay direct digital capture technology — its role in the future of the radiology department
J Bell
Sterling Diagnostic Imaging (UK) Limited, Stevenage, Herts SG1 2EF, UK
As we move inexorably towards a future increasingly dominated by computer technology the implications and opportunities for the radiology department and the healthcare environment as a whole are substantial. Radiology practises, many of which have remained largely unchanged for decades, are now under scrutiny, and exciting opportunities are emerging. This presentation will describe and examine one such area, specifically that of direct digital image acquisition in general projection radiography using DirectRay technology. Included will be an overview of the fundamentals behind the technology, its place within the radiology department, and an analysis of the primary benefits to the patient, radiology department and healthcare provider. DirectRay is the first commercially available full size direct digital capture technology suitable for use in the majority of general radiographic applications. The first systems dedicated to chest imaging were introduced during the second half of 1998, followed by a general/trauma system during the first half of 1999.

1000
Invited Review
Technology available
J N Garbutt
Philips Medical Systems, Kelvin House, 63–75 Glenthorne Road, Hammersmith, London W6 0LJ, UK
This paper will address the various technologies that are available as image receptors in place of conventional film screen combinations. The benefits of technologies such as computed radiography and direct digital radiography will be discussed as well as looking into future technologies.

1015
Invited Review
Potential benefits of the new direct digital flat detector technology
J Levett
Siemens plc., Siemens House, Oldbury, Bracknell, Berks RC12 8FZ, UK
The new digital detectors currently being developed by a number of imaging companies around the world, either individually or in collaboration, will finally begin to close the gap that exists within the modern imaging department. Namely, the requirement to use cassette-based as opposed to direct to digital technologies to image a not insignificant number of the patients passing through such departments. This talk will discuss the potential benefits of the implementation of these new technologies within a department and also the necessary changes that will be required in both working and equipment procurement practices.

1030
Invited Review
The clinical use of DirectRay Radiography — the first year's experience, The Royal Victoria Infirmary
L Richardson
Radiology Department, Royal Victoria Infirmary, Newcastle Upon Tyne NE1 4LP, UK
We have been using DirectRay (DR) Radiography from Sterling Diagnostic Imaging since March 1998. This is a pre-production model installed into a general Philips radiography room with minor alterations to the chest stand. The system comprises of the plate, monitor and associated computer. We have undertaken a formal trial comparing DR with Computerised Radiography (CR) for chest radiography. This has shown that greater dynamic range and high level of resolution does transpose into highly diagnostic images which were liked by both radiologists and chest physicians. The radiographers found the system generally easy to use even though it is a pre-production model. Images are acquired extremely quickly (an image is obtained on the monitor in 15 s after exposure). This is used to check radiographic positioning and if satisfactory the patient can leave. The final image can be viewed as a soft copy within seconds or as a hard copy from the laser printer a few minutes later. The system therefore does not require cassettes to be carried to a film reader or processor and greatly increases the throughput of the diagnostic room and the workload of the radiographer. The radiologists have generally preferred the DR images to CR images. This will be discussed further.

1050
Invited Review
Comparison of CR and DR
P Hawkridge, M M Gallivan and R F Bury
Radiology Department, The General Infirmary at Leeds, Great George Street, Leeds LS1 3EX, UK
Photostimulable phosphor computed radiography (CR) is an established technique for the acquisition of digital images. CR can be used for all general radiographic examinations and may also be used in cassette based fluorographic applications. Over recent years CR has proved itself a viable alternative to film/screen radiography. Technical advances in X-ray detector technology have been focused

on the solid state acquisition devices, generically referred to as flat-panel, or DR systems. Unlike CR systems, where a latent X-ray image is stored on an imaging plate prior to scanning and digitizing, DR devices have a direct electronic readout of the digital image data. Areas of application for DR devices include general radiography, and also dynamic image acquisition, for example fluoroscopy. A brief review of differing DR technologies will be presented. The relative advantages and disadvantages of CR and DR in clinical application will be discussed. Currently most DR systems currently exist in prototype form. The General Infirmary has extensive experience of the Philips Thoravision, a selenium based thoracic imaging system, and also has a demonstrator of a flat panel fluoroscopy system for clinical and technical assessment. Technical measures of imaging performance on these devices within the LGI have proved that DR devices can provide excellent imaging performance when compared with current CR systems. The technical measurements have been confirmed by the our clinical experiences, which also demonstrate excellent image quality and show potential dose savings.

1110
Invited Review
Integration of CR/DR into PACS
C Bull
Imation UK Ltd, Imation House, Bond Way, Bracknell, Berks RG12 1LQ, UK
PACS and digital imaging exist with many limited CR users and a few trial DR users. When plain X-ray imaging, in the form of CR or DR, is added into any digital solution it brings many technological challenges with it in three ways: acquisition, archiving and viewing. *Acquisition:* Most CRs support DICOM with direct references to CR image acquisition. *Archiving:* View of patient folders, intelligent pre-fetching and distribution of data to user requirements. Data management, cost effective digital storage along with performance are always key issues. Allowing expansion to the archive as the requirements change and moving to a full Electronic Patient Record (EPR) in a central system. *Viewing:* Workstation type for given users is the key acceptance for PACS. Outside radiology a workstation for clinical use must be able to deliver images, patient history and related information. For PACS image maintenance is a major issue. Perception with image displays from different manufacturers and CR units and other imaging hosts, *i.e.* CT and MRI. DICOM is starting to gain acceptance with grey scale display function (GSDF) to allow good softcopy presentation linked by both monitor display factors, room lighting and image being viewed.

1130
Discussion

1015–1130
Scientific Session
Skill Mix and Changing Roles for Radiographers: The Evidence
Hall 5

1015
Recommendations for the implementation and management of skill mix in diagnostic imaging
M J Lovegrove, A Taket, H B Bentley, S V Hay and C Hawkes
Centre for Research in Professions Allied to Medicine, South Bank University, London SE1 0AA, UK
In 1996, South Bank University was commissioned by the Department of Health, under its "Human Resource and Effectiveness Initiative" to undertake a study of the implementation and management of skill mix in diagnostic imaging centres; seven throughout England and one in Scotland. This study has shown that the extent of skill mix in diagnostic imaging is much greater and more diverse than previously reported in other studies. The main agents for change were: the emphasis the NHS has recently put on the innovative use of skill mix; insufficient radiologist time; increasing workload and interest in skill mix by non-medical staff. The research did not produce any evidence that the quality or effectiveness of the examinations studied had been jeopardized by skill mix. This paper presents the main findings of the study and recommendations for the implementation and management of skill mix in diagnostic imaging.

1025
Changing times: a national survey of extended roles in diagnostic radiography
R C Price, S B Le Masurier, J High and L R Miller
Department of Radiography, University of Hertfordshire, Hatfield, Hertfordshire AL10 9AB, UK
PURPOSE: Much interest has been shown in the developing role of the radiographer but minimal data exist to show the extent of changes. The purpose of this research was to identify the extent and scope of practice in radiography. METHOD: Questionnaires were sent to 276 NHS Trusts. Respondents were asked to identify their region and whether the Trust was classified as teaching or non-teaching. Information was sought on extended role tasks and the year in which they were adopted. Staff numbers were sought to investigate any correlation between the ratio of radiographers to radiologists and change of practice. RESULTS: There was an 83% response rate. A red dot system was in operation in 162 Trusts, the earliest since 1966. Radiographers in 205 Trusts performed IV injections. 38 Trusts indicated no reporting by radiographers; 37 Trusts stated there was reporting in accident and emergency. There were no radiographers reporting on chest films and one Trust indicated that paediatric films were reported by radiographers. Mammograms were reported at 10 non-teaching Trusts. Ultrasound provided the largest response where 150 Trusts indicated reporting by radiographers. 37 Trusts confirmed reporting on barium studies but a total of 122 sites stated that radiographers carry out barium enemas. With the exception of IV injections, extended role activities were greater in non-teaching than teaching Trusts. CONCLUSION: The study demonstrated the extent to which Trusts are utilizing the developing skills of radiographers. This has important implications for education and future delivery of imaging services.

1035
A national survey of extended roles in therapeutic radiography
J High, L R Miller, S B Le Masurier and R C Price
Department of Radiography, University of Hertfordshire, Hatfield, Hertfordshire AL10 9AB, UK
There are conflicting claims regarding the extent to which therapeutic radiographers have taken on additional duties in recent years. Some claim widespread introduction of "the extended role" (extended practice requirements arising from either changes in practice or by adopting tasks more traditionally performed by others), while others claim that there has been little change — indeed some say the role has contracted. In order to ascertain levels of radiographer activities in the therapy domain a questionnaire was sent to all radiotherapy departments in the UK ($N=62$) during the summer of 1998. Replies were received from 52 departments (84%). The extent of role change in therapeutic radiographers was quantified, along with qualitative information regarding the nature of those changes. Areas in which radiographers reported significant levels of activity were computer planning (52%), information officer responsibilities (50%), treatment review clinics (33%), counselling as part of primary role (27%) and treatment volume decisions (21%). Activities identified at a smaller number of departments included quality assurance (15%), image analysis (12%), and "dispensing standard pharmaceuticals" or "administering first line drugs" (10%). Across the UK there is wide variation in the rates of radiographers undertaking tasks categorized as part of the extended role; for some areas, up to half the sites reported involvement, whereas for other activities few sites reported activities. Furthermore, the extent to which such changes are long-standing or introduced relatively recently varied widely. The extent of role change reported has implications for education of radiographers to maintain quality of cancer services.

1045
The changing role of the superintendent radiographer
N J Prime and T Forbes
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PURPOSE: To investigate how radiography managers perceive their current roles and how these roles have evolved over time. MATERIALS AND METHODS: A convenience sample of radiography managers (service managers, senior superintendents and those with business manager responsibility) ($n=22$) was selected by the researchers. The radiography managers were based in both the west of Scotland and south east England. A semi-structured interview technique was used and the outcome of the interviews taped and transcribed. All interviews were conducted by one researcher.

Questions posed focused on the radiography manager's experiences of their current and past roles. Analysis of the transcripts was conducted independently by the researchers and then compared for common themes. RESULTS: Responses by managers in both Scotland and England were broadly similar. Managers identified very strongly with their clinical roots and agreed that radiography managers should have clinical radiography experience. All managers also identified strongly with their role as managers, viewing this as a strategic role. In commenting on the balance between "radiographer" and "manager" some managers felt there was a tension between the two roles with problems associated with the representation of radiographer interests. Tensions and stresses were also noted in dealing with stakeholders in radiography. Changes in management style, the need to learn quickly and poor preparation for the role of manager were also commented on. CONCLUSION: The research mapped out the characteristics of an important area of management in the NHS while identifying ways in which managers of radiography and other similar services may be best prepared for their role.

1055
A clinical radiographer in medical physics: a career opportunity
C Chapman-Jones
Department of Medical Physics, Kent and Canterbury Hospital, Canterbury, Kent CT1 3NG, UK
The extended role of the radiographer has been developed in many areas beyond what would have been considered as the boundaries of the role 20 years ago. A new and innovative post was designed within the Medical Physics department at the Kent and Canterbury Hospital that called not only for a background interest and knowledge of radiology physics but also the clinical experience of a qualified radiographer. By combining a continued skillbase in radiography and adding a new knowledge base in the philosophy of radiology physics support, a position has been created that crosses both clinical and physics boundaries enabling a greater understanding of the needs of an X-ray department and the clinical application of the information available from the physics department. The expertise of the radiographer ensures development of the support provided by Medical Physics by making it relative to the day to day management of an Imaging department. The core duties of the post include equipment assessment, patient dosimetry, local quality assurance, critical clinical applications review and research as part of a multidisciplinary team. Progress in each area of responsibility is carefully linked to the ability and experience of the appointee and reviewed regularly. This extension to the role of the radiographer has few boundaries and promises career opportunities in radiology management and quality systems.

1105
The medical physics radiographer: the physicist's view of creating and managing the post
M Hanson
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In July 1997, the Medical Physics department at the Kent and Canterbury Hospital took the innovative step of appointing a medical physics radiographer to join a team providing physics support services to Radiology. The appointment has already proved to be highly successful. This paper describes how the motivation to create this appointment came from a genuine appreciation of the value of skill mix and the multidisciplinary team. Key managerial aspects will be discussed, including the development of the job description, the availability of suitable candidates and training. The important issue of the relative merits of a medical physics radiographer and a radiology physicist will be addressed, highlighting that our move should represent progress and not conflict with regard to career opportunities. Examples will be given of how the addition of new skills to the support team through this appointment have increased our ability and versatility in various areas, including equipment assessment and use, equipment specifications, and research. Finally, the popularity and support for this appointment from various Health Service professionals will be outlined and our vision of how this initiative will progress will be presented. This paper is supported by a parallel presentation by the appointee, providing the corresponding perspective.

1115
Maximum activity with minimum resources
S McWilliam
The Plymouth Oncology Centre, Derriford Hospital, Plymouth PL6 8DH, UK
PURPOSE: The purpose of this presentation is to suggest how increased activity can be achieved in radiotherapy with reduced staffing. METHOD: In order to do this, strategic objectives were set and a review undertaken to identify tasks and process necessary objectives. Tasks were allocated to appropriate staff groups, irrespective of historical ways of working. Processes were reviewed to eliminate duplication and consider afresh where, when and by whom each element should be performed. RESULTS: As a result of this exercise, fewer staff are treating more patients in less time and with a higher quality of service delivered. CONCLUSION: The results suggest that new technology requires new ways of working in order to improve cost effectiveness without compromising outcomes or patient care.

1125
Discussion

1015–1130
Scientific Session
Imaging Prostatic Cancer
Hall 8

1015
Invited Review
Imaging prostate cancer
D MacVicar
Department of Diagnostic Radiology, The Royal Marsden Hospital, Sutton SM2 5PT, UK
Prostate cancer is becoming more common, predominantly but not exclusively as a result of ageing of the male population, and public awareness of the disease is increasing. This review will consider the role that imaging plays in making the diagnosis at presentation in symptomatic men, and discuss characteristic features of the disease on ultrasound and MRI. The current consensus is that transrectal ultrasound (TRUS) is a suitable method for confirming the diagnosis as it enables guided biopsy, although the appearance of prostate cancer is variable. Local stage may be assessed by TRUS or MRI. The literature shows staging accuracy is higher with MRI, and both techniques are more accurate than clinical assessment. Adequate images can be obtained on low field systems, and technological developments such as endorectal coil MRI have not always led to increased accuracy. The role of CT is limited to nodal staging and radiotherapy planning. Isotope studies and skeletal radiography were once "routine" for prostate cancer, but it is rarely necessary to investigate for metastatic disease in patients with early prostate cancer and prostate specific antigen (PSA) of less than 10 ng ml^{-1}. Follow-up investigations should be directed by clinical and biochemical status. Nodal and bone deposits frequently cause complications such as renal obstruction or cord compression and should be investigated promptly by appropriate techniques. Imaging the prostate following treatment for cancer is difficult and rebiopsy is usually necessary to diagnose local recurrence.

1045
Does adopting free/total PSA improve diagnostic yield in TRUS guided biopsies of the prostate?
[1]M E K Sellars, [1]B G Conry, [1]J J Flanagan, [2]J L Lewis and [2]T F Ford
Departments of [1]Radiology and [2]Urology, Kent and Sussex Hospital, Mount Ephraim, Tunbridge Wells, Kent TN4 8AT, UK
Prostate specific antigen (PSA) is not a marker for malignancy being elevated in both benign and malignant disease. The free to total PSA ratio is said to be useful in distinguishing between those two pathologies, particularly in those patients with normal or slightly elevated total PSA values. OBJECTIVE: To determine whether the positive yield of transrectal ultrasound guided biopsies was altered after the Kent and Sussex Hospital began to measure the PSA ratio in January 1997. A value of 0.25 was accepted as being the lower limit of normal, below which the prostate biopsy threshold was set. MATERIALS AND METHODS: The number of biopsies and the percentage with malignant histology were compared over a 1 year period before (group one) and after (group two) the introduction of the free to total PSA assay. All scans were performed by a single operator (BGC). RESULTS: 51 of the 132 biopsies in group one were positive (38.6%) and 37 of the 76 in group two (48.6%). CONCLUSION: There was a significant difference in the total number of biopsies performed and number of positive results obtained when comparing the different PSA screening techniques. The free to total PSA ratio allows detection of more cancers and results in fewer negative biopsies.

1055
Management of patients treated with aspirin/warfarin prior to prostatic biopsy: survey of current practice
S E J Connor and J Wingate
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PURPOSE: Profuse haematuria or rectal bleeding is a rare but recognized complication of transrectal ultrasound (TRUS) guided prostatic core biopsy. The object of this study was to document current practice concerning the management of patients taking aspirin or warfarin prior to prostatic biopsy. It was our experience that there was a difference in practice between radiologists and urologists, so both groups were studied. METHOD: A postal survey was performed with typed questionnaires being sent to 275 urology and 275 radiology centres. Information about the number and type of prostatic biopsy performed was requested. Questions were asked concerning detection of patients taking warfarin or aspirin, presence of departmental protocols, performance of blood tests and withdrawal of the anticoagulant or antiplatelet therapy. Finally, it was asked whether there had been communication with physicians or whether cases had been postponed due to unexpected treatment with warfarin or aspirin. RESULTS: There was an overall response rate of 62%. Wide variations in practice, both between and within the radiologist and urologist groups, were documented. The results will be presented and related to the current evidence concerning the effect of antiplatelet or anticoagulant therapy and haemostatic abnormalities on bleeding associated with ultrasound guided biopsy procedures. CONCLUSION: The presence of formal recommendations is required to establish greater uniformity in management.

1105
Accuracy of endorectal MRI in prostatic carcinoma—comparison with pathological findings
[1]M J Cleasby, [1]K Sandrasegaran, [1]A K Banerjee, [1]D C Tudway, [1]R Puni, [2]R S Jaganathan, [2]B D Sarmah and [3]J Newman
Departments of [1]Radiology, [2]Urology and [3]Pathology, Birmingham Heartlands Hospital, Birmingham B9 5SS, UK
PURPOSE: To assess the accuracy of endorectal coil MRI in predicting extracapsular, seminal vesicle, neurovascular invasion in early prostatic carcinoma compared with pathological findings. MATERIALS AND METHODS: Of 44 patients who underwent endorectal coil MRI for prostatic cancer 17 had radical prostatectomy. The urologists used the radiological information in deciding the operative procedure. Two observers (KS, AKB) independently and blindly scored on a modified Likert scale the endorectal and pelvic MRI images for site of tumour, extracapsular spread, seminal vesicle and neurovascular invasion, involvement of urethra at apex and local lymphadenopathy. The radiological interpretation was correlated with pathological findings of the surgically resected specimens. RESULTS: The interobserver correlation for MRI was excellent ($r=0.84$). Multivariate analysis of radiological and pathological findings showed significant correlation for extracapsular invasion ($p<0.05$), seminal vesicle invasion ($p<0.01$) and urethral involvement ($p<0.05$). The correlation was weaker for the intraprostatic site of tumour ($0.05<p<0.10$). The radiological findings correctly predicted tumour confined to the gland in 15 of 17 cases. In 12 cases the improved resolution of endorectal coil images over body coil images significantly assisted the radiologist in assessing tumour spread. CONCLUSION: Endorectal coil MRI of prostatic carcinoma is well tolerated and useful in deciding which patients will be suitable for radical prostatectomy.

1115
The use of restricted diffusion in distinguishing between benign and malignant tissues in the prostate
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Centre for MRI, Hull Royal Infirmary, University of Hull, Hull HU3 2JZ, UK
PURPOSE: To determine whether restricted diffusion is evident in the prostate and to evaluate the use of restricted diffusion weighted imaging in differentiating benign and malignant tissues in the prostate. MATERIALS AND METHODS: Diffusion weighted echo planar images were obtained on a 1.5 T IGE Signa echospeed scanner with TR/TE = 4000/110 ms, NEX = 16, FOV = 19 cm, matrix size = 96 × 96, slice thickness = 7 mm with a scan time of 8.44 min for each set of 8 points. Five patients and three volunteers were scanned with the diffusion gradient applied in both the Y and X directions. Scanning was performed using the Stejskal and Tanner method with gradient duration of 20 ms and gradient lobe separation of 43.4 ms giving a diffusion time of (Δ $\delta/3$) = 36.7 ms. The diffusion gradient was increased in 0.1 gauss cm^{-1} steps from 0.6 to 2.0 gauss cm^{-1}. This was done in two separate scans of eight diffusion gradient steps owing to software limitations. The scans overlapped at one value of the diffusion gradient to allow assessment of the continuity of the scanning parameters. RESULTS: After acquisition, regions of interest were drawn by a radiologist in tumour central gland/BPH and normal peripheral zone. These were then analysed over the increasing gradient. Preliminary results from the plots of gradient squared against the log of the signal intensities show some evidence of restricted diffusion at increased diffusion weighting. Significant differences were found between the apparent diffusion coefficients (ADC) for the six highest diffusion weightings in regions taken from the tumour (4.04E–4 mm^2 s^{-1}), the central gland (5.2E–4 mm^2 s^{-1}) and the peripheral zone (6E–4 mm^2 s^{-1}). The volunteers give values for the ADC of 5.2E–4 mm^2 s^{-1} and 4.9E 4 mm^2 s^{-1} in the central gland and peripheral zone respectively. This compares with the values obtained from the patients shown above. CONCLUSIONS: The results indicate that restricted diffusion can be used to differentiate between tumour and other tissues in the prostate.

1125
Discussion

1030–1130
Scientific Session
CARS/*info*RAD™—Review of Image Guided Surgery
Hall 11B

1030
Invited Review
Enabling technologies for image guided surgery
H U Lemke
Institute for Technical Informatics, Technical University Berlin, Fr 3-3, Franklinstr. 28/29, Berlin, Germany
PACS and telemedicine systems are now being accepted as enabling infrastructures for improving quality of and access to health care. Increasingly, computer aided therapy, in particular computer aided surgery, is being realized by these modern medical computer and communication systems. Tools based on computer aided surgery facilitate completely new ways of patient care. In this context, image guided surgery (IGS) is a concept and tool whereby surgeons can benefit from digital images and 3D reconstructions. This facilitates the following surgical activities: (a) preoperative surgical simulation and planning; (b) intraoperative navigation; and (c) postoperative evaluation. Clinical applications of IGS can be found in e.g. neurosurgery, head and neck, orthopaedics, ear nose and throat, cardiovascular and thoracoabdominal surgery, and plastic/reconstructive surgery. A review of prototype and clinical IGS systems will be given in this presentation.

1100
A dynamic approach to computer modelling of bone
T Bowles, S Golding, D Dobson and S Watt-Smith
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INTRODUCTION: In facial reconstructive surgery, success may depend on accurate surgical planning and simulation, and prediction of results. Software programmes for 3D display or modelling have a proven place in planning reconstructive surgical procedures. However, static techniques do not take account of the complex nature of bone and the unpredictable behaviour of pathological bone when responding to treatment measures. For this reason they are deficient in failing to predict how materials will behave dynamically under the influence of biological forces and external intervention. METHODS AND RESULTS: This paper presents an approach to dynamic modelling of materials, using simploid-based technology in which simploids are used to store material and connectivity information, represented as discrete domains which combine with finite element techniques to provide a fast and accurate modelling approach. Software has been written to allow creation of force plates to simulate distraction techniques in distraction of bone as the simplest biological example. The software is demonstrated on known materials before being applied to bone. Inductive logic programming is investigated as the method that could solve the issue of modelling a complex and sometimes unpredictable material. CONCLUSION: This method holds the promise of introducing a reliable dynamic element into computer-assisted planning for reconstructive surgical procedures.

1110

Skeletal growth estimation using an automated knowledge-based vision system

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Skeletal age assessment is often required in diagnosing or monitoring growth disorders, or in some cases as an aid to predicting ultimate height. It is also potentially useful for legal purposes when evidence of a young person's age is either unavailable or deemed inaccurate (suspicious). The two main methods used in paediatric radiology are attributed to Greulich & Pyle and Tanner & Whitehouse. Both methods are based on assessment of bone morphology from hand radiographs but are laborious and prone to interobserver and intraobserver inconsistency. We present initial results of an automated knowledge-based vision system to segment bones in hand radiographs and evaluate skeletal growth using a Bayesian estimation. The techniques used will be described. The following shape and texture descriptors applied to the proximal phalanx of the middle finger are shown to produce a feature vector that can be used for age estimation: principal component coefficients (PCC); shape moments (MOM); epiphysis to metaphysis ratio (EMR); epiphysis curvature measure (ECM); texture (TEX). A Bayesian decision making algorithm is applied to the descriptors to estimate growth age. Results presented will include: correlation coefficients of descriptors with age; variance inferences for descriptors (with 95% CI); estimation accuracy using different combinations of descriptors (with 95% CI). The technique is robust, free from observer bias and population independent.

1120

Discussion

1045–1215
Scientific Session
Vascular Imaging and Intervention 1
Hall 11A

1045

Three point compression ultrasound in the imaging of acute symptomatic DVT

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PURPOSE: To confirm or refute the findings of a recent multicentre centre study that a limited three point compression ultrasound technique can be used in the imaging of patients with acute symptomatic DVT to identify patients at risk of thromboembolic disease safely and accurately. METHOD: All 512 patients in whom imaging for acute symptomatic DVT was requested over a 10 month period were scanned with a modified three point colour compression technique. Unequivocally normal first scans were followed by a second scan the next week. Equivocal scans required further imaging. RESULTS: 98/512 (19%) first scans were positive. In 38 (7.5%) patients another cause for symptoms (Baker's cyst, haematoma, etc.) was identified. 283 of the remaining 376 patients attended for second scans. Only 3/283 (1%) second scans were positive, all in patients with high risk factors. No patients (follow-up 4–10 months) with two negative scans have yet presented with signs and symptoms of venous thromboembolism. Imaging requests have more than tripled. CONCLUSION: Three point compression ultrasound is quick, requires little skill and used in conjunction with low-molecular weight heparin has considerable implications for rapid outpatient diagnosis and treatment of DVT. It appears to be a safe and accurate screening test to identify patients at risk from venous thromboembolism, although selected patients will still require full duplex or venography. It represents an increased workload as a second scan is required and the threshold for requesting imaging decreases. It is likely, however, that the second scan can be abandoned if the technique is used in conjunction with risk probability factors and D-dimer evaluation.

1055

The value of contrast-enhanced 3D MRA in the pre-operative evaluation of patients with aorto-iliac disease

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PURPOSE: To evaluate the usefulness of contrast-enhanced 3D MR angiography (CE MRA) as an alternative to trans-lumbar or brachial angiography in the pre-operative work-up of patients with aorto-iliac disease. MATERIALS AND METHODS: 16 patients (M:F, 12:4; mean age, 62 years; range, 45–77 years) with aorto-iliac disease precluding femoral puncture for trans-femoral angiography underwent pre-operative CE MRA and conventional angiography via the trans-lumber ($n=3$) or brachial ($n=13$) route. All patients subsequently underwent surgical or interventional treatment for their vascular disease with on table angiograms performed in selected patients. RESULTS: CE MRA correctly diagnosed the presence of aortic ($n=8$), iliac ($n=2$) or combined aorto-iliac occlusions ($n=6$) in all patients when compared with conventional angiography. It also correctly determined the level and extent of occlusion in all patients although the degree of stenosis was overestimated in 2 patients with iliac disease. The distal vessels were visualized down to the common femoral arteries in all patients and to the level of the proximal superficial femoral arteries in 7 patients. 13 patients underwent axillo-bifemoral bypass surgery, 2 patients had percutaneous iliac stent placement and one patient had aortic embolectomy based on these findings. CONCLUSION: CE MRA gave anatomical detail of the occlusion, proximal aorta and distal run-off sufficient to plan surgery and should therefore be considered as the first line of investigation in such patients.

1105

The role of interventional radiology in the management of failing Brescia–Cimino arteriovenous fistulae

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PURPOSE: To evaluate the efficacy of percutaneous angioplasty of failing Brescia–Cimino arteriovenous fistulae. MATERIALS AND METHODS: Seven patients (four males and three females) with an age range of 35–76 years were referred for fistuloplasties owing to decreased flow during dialysis. Four long segment proximal vein stenoses (brachicephalic vein ($n=1$), subclavian vein ($n=2$) and cephalic vein ($n=1$)) and three short segment stenoses of the venous anastomotic site were delineated on the initial fistulograms. A total of 15 angioplasties were performed in our patient group and their fistula patency monitored over a 6 month period. In one patient, six angioplasties and two stents were deployed. RESULTS: Initially, satisfactory technical and haemodynamic results were obtained in all patients. Primary patency was described as no radiographic or surgical intervention in less than 6 months following angioplasty. Primary patency was less than 2 months in two patients with venous anastomotic stenosis. In four patients, primary patency was achieved with good venous flow to this date. In one patient where initial primary patency failed, stent insertion achieved good venous flow for 11 months. However, a second stent insertion was required to maintain patency. CONCLUSION: Angioplasty is technically a simple and effective means of prolonging the life of stenotic arteriovenous fistulae. Repeated angioplasties improves venous flow and in some cases, stent insertion is necessary to maintain patency.

1115

Percutaneous transluminal angioplasty of post-endarterectomy internal carotid artery stenosis

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AIMS: Limited information is available regarding the success of percutaneous transluminal angioplasty (PTA) of post-endarterectomy internal carotid artery (ICA) stenosis. We present our results. METHOD: Nine patients with recurrent ICA stenosis after carotid endarterectomy (CEA) were treated with PTA. The mean interval between CEA and PTA was 15 months. All patients had a stenosis of >80% on follow-up Duplex scans. Angioplasty was performed using standard technique including monitoring with transcranial Doppler and cerebral oximetry. Post-procedure duplex scans were performed at 1 day, 6 weeks, 3 months and 6 months and 6 monthly thereafter. RESULTS: Immediate technical success was achieved in eight of nine patients with a reduction in the stenosis to <50%. The remaining patient had significant recoil after PTA and a stent was placed with a good result. No significant ischaemic event or neurological impairment occurred during the angioplasty procedure. A contralateral intracerebral haemorrhage occurred in one patient 8 hours after angioplasty and the patient died 8 days later. The mean follow-up interval in the remaining eight patients was nine months (range 3–20 months, median 6 months) and all patients were asymptomatic. In one patient the artery had occluded

at the 3 month review. In the patient who had required a stent there was a recurrent stenosis of 70% within the stent. In the remaining six patients the treated artery remained widely patent. CONCLUSION: PTA for recurrent ICA stenosis is a useful technique and medium term patency results are promising.

1125
Radiological placement of subcutaneous arm ports—indications, technique and complications
R Vaidhyanath
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24 arm ports for chronic venous access were placed over a two and a half year period in a standard digital screening room in the Radiology Department. Comprehensive follow-up totalling 3,872 days was obtained. Immediate technical success was achieved in all but one patient. Four minor complications occurred, one episode of phlebitis, one persistent ooze in a thrombocytopenic patient, an episode of suspected infection responding to antibiotics and a suspected catheter occlusion cleared with Urokinase. This gives a minor complication rate of 1.03 per 1,000 access days. There were two major complications, an irretrievable kink of the catheter requiring exteriorization of the catheter and one detachment and proximal migration of the catheter requiring snaring and re-attachment; giving a major complication rate of 0.52 per 1,000 venous access days. The complication rate compares very favourably with that of subcutaneous devices inserted in theatre or devices placed using a more standard chest approach. The patient population benefiting from these procedures, advantages of arm position and techniques of insertion are discussed.

1135
Lower limb angioplasty—a day case procedure?
[1]C Keogh, [2]A Branigan, [2]K O'Malley, [2]T Corrigan, [1]D Legge and [1]J G Murray
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PURPOSE: To assess the feasibility of performing lower limb angioplasty as a "day case" procedure. METHODS: A prospective study was performed involving 50 consecutive patients presenting for lower limb angioplasty over an 8 month period. There were 30 males and 20 females aged 35–84 years (mean 66.4). Lesions consisted of 55 stenoses and 12 occlusions and were located in the iliac arteries $n=13$, femoral arteries $n=36$ or popliteal/tibial arteries $n=18$. Patients were confined to bed for 6 h and then mobilized. Complications were recorded at the time of procedure, at 6 h and after 24 h. RESULTS: Angioplasty was technically successful in 47 of 50 cases (94%). 5 patients developed complications during or immediately after the procedure: 4 minor haematomas which stabilized following additional compression and 1 subintimal dissection. 2 patients developed complications between 0 and 6 h (delayed haemorrhage and a pseudoaneurysm), both managed conservatively without consequence. No patient developed a complication more than 6 h after successful angioplasty. CONCLUSION: Lower limb angioplasty can be performed as an out-patent procedure in 82% of cases. Patients requiring more prolonged hospital stay can be identified on the basis of failure of the initial angioplasty or complications arising within 6 h. These findings are important both in terms of increasing the availability of angioplasty and diminishing its overall cost.

For Work in Progress contributions to this session see p. 89.

1200–1245
British Institute of Radiology
Kodak Mayneord Memorial Lecture
Hall 5

1200
Eponymous Lecture
Advances in ultrasound: from microimaging to telerobotics
P N T Wells
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Whilst the traditional role of ultrasound in clinical radiology continues to be refined and developed, the horizons of the subject are expanding as new techniques are conceived and novel applications are identified. Microimaging and telerobotics are typical of these novel applications. Advances in transducers, digital electronics, signal processing, image manipulation and display have made it possible to produce three-dimensional images of small volumes of tissue with micrometre resolution. In addition to B-scanning, which already has applications in skin, tumour and lung microimaging, novel approaches based on CT, reflex transmission, synthetic aperture and Doppler scanning are beginning to be explored. There is also potential trackless microintervention. The use of traditional ultrasonic imaging methods for remote diagnosis and for remote guidance of interventional procedures is now being shown to be feasible. There are formidable problems in the development of the appropriate robots, the systems for image acquisition, the transmission of the data, and the remote workstations. The concept of the spatial reference frame is fundamental and the use of the ultrasonic image for this purpose, rather than the patient, is already practicable. Ultrasonic image-guided minimally invasive intervention, whether performed locally or remotely, is likely to be a routine procedure in the surgery room of the future.

1300–1345
British Institute of Radiology
Mackenzie Davidson Memorial Lecture
Hall 5

1300
Eponymous Lecture
The percutaneous management of arterial disease
D Vorwerk
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Percutaneous treatment of arterial disease is now widespread and many different techniques are available. Their application depends on the location, age and nature of the obstruction that has to be treated. Acute obstruction due to arterial embolism or occlusion may undergo aspiration embolectomy, chemical thrombolysis or mechanical thrombectomy. For mechanical thrombectomy, different devices are available that have their own indication, especially if a long segment thrombosis occurs or chemical thrombolysis is contraindicated. Treating fresh thrombotic occlusions always produces a risk of embolization of occluding particles further down, but combining different techniques and non-traumatic catheter material allows thrombectomy even from the lower limb arteries. Balloon angioplasty is still the backbone technique in the treatment of chronic disease, and is the most acceptable technique for short-segment stenoses and occlusions in all vascular provinces including the supraaortic arteries. There is no proof that any other percutaneous technique is superior to PTA in infrainguinal arteries. With the use of appropriate balloons, balloon angioplasty is also feasible in the lower limb arteries but should be limited to cases where limb salvage is an issue. Stent placement has achieved an important role in the treatment of iliac and renal obstruction and in supraaortic arteries, especially in the carotids. Mainly, it should be limited to cases where PTA has a primarily poor prognosis, or poor outcome of PTA requires additional intervention. In the infrainguinal arteries, stent placement should be applied with care. Atherectomy is required in selected cases with marked eccentric and calcified stenosis; stent grafts may be used in isolated aneurysms and fistulas. Use of stent grafts in atherosclerotic lesions alone, however, has not yet been defined.

1400–1530
Scientific Session
A&E Imaging
Hall 5

1400
Blunt abdominal trauma: maximizing resource utilization by limiting CT scanning to peritoneal lavage — positive cases
B Sharma, M R Paley, M Farrugia, T M Hodgetts, H Parkhouse and C Whitton
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The diagnosis of haemodynamically significant intra-abdominal injury is one of the most difficult problems in trauma management.

There remains no clear consensus as to whether diagnostic peritoneal lavage (DPL), ultrasonography (US) or computed tomography (CT) should be used as the first line investigation in haemodynamically stable patients. We present an audit based on a busy trauma centre, assessing 75,000 patients a year, a large proportion of which involve motor vehicle accidents. 102 patients (age range 2.3 to 84 years) were assessed over an 18 month period. DPL, US and CT examinations, both in isolation and in combination, were analysed. This was correlated with the laparotomy findings and the clinical outcome. The results of this protocol are presented. This is followed by the results after closure of the audit loop with the gold standard of DPL used as the initial investigation and CT examination being limited to DPL-positive patients only. The audit results show that limiting CT to patients who are DPL positive is safe, reduces the overall cost, maximizes resource utilization and results in a lower rate of negative laparotomies compared with CT or DPL alone. We present an algorithm for the clinical management of patients with blunt abdominal trauma.

1410

Guidelines for emergency cranial CT in adults with no history of head trauma

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BACKGROUND: A recent American study by Rothrock et al considered clinical factors which might predict significant CT findings in non-trauma patients in the Emergency Room. Limiting CT to patients with special clinical criteria missed no significant pathology. AIM: To apply the criteria defined by Rothrock et al and determine whether modifications could be made to improve efficiency in a UK setting. METHOD: A prospective observational study was conducted over a four month period, including all non-trauma adult patients referred from Accident & Emergency for urgent cranial CT. Presenting symptoms and signs were analysed for ability to predict clinically significant CT findings (defined as: 1. acute stroke, 2. CNS malignancy, 3. acute hydrocephalus, 4. intracranial haemorrhage, 5. intracranial infection). RESULTS: 62 patients were included. 22 (35%) had significant CT findings. Applying the Rothrock et al criteria–any of: 1. age >60 years, 2. focal neurology, 3. headache with nausea/vomiting, 4. altered mental status to our study population, showed no clinically significant CTs would be omitted (100% sensitivity) and 11% fewer CTs performed. Refining the criteria as any of: 1. focal neurology, 2. headache with nausea/vomiting, 3. GCS < 14 still ensured 100% sensitivity and resulted in a 19% reduction in CTs. CONCLUSION: We have confirmed that guidelines proposed by Rothrock et al can be usefully applied to patients presenting to an A&E department in this country and suggest a refined, simplified version which can be used to target patients most likely to have clinically significant findings on urgent cranial CT.

1420

Assessing the impact of timing of cranial CT in patients with skull fractures on outcomes

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PURPOSE: To assess the impact of timing of cranial CT scans in patients with head injuries where the main indication is the presence of a skull fracture. METHOD: Over a 20 month period all patients undergoing a cranial CT scan with documented skull fractures on radiographs after head injury were identified and 29 complete records analysed. Glasgow coma scale (GCS) scores and the time interval between admission and CT being carried out were recorded, together with CT findings and clinical outcomes. RESULTS: 13/29 patients had their CT within 4 h of arrival in the A&E Department. Of these, eight patients had GCS scores of 4–12 and five patients GCS scores of 14 15. Four patients were transferred to the Neurosurgical unit, one patient died and the remaining eight were managed locally and discharged after a period of 3–25 (mean 9) days. 16/29 patients underwent the CT scan after the initial 4 h period. Of these, two patients had GCS scores of 14 and the remaining had GCS scores of 15. 13/16 of these patients were managed locally and discharged within 2–16 (mean 4.6) days. Three patients were transferred to the Neurosurgical unit, but not operated on immediately, all of which were for depressed fractures not seen on the skull radiographs. CONCLUSION: In patients with high GCS scores and skull fractures, delay in carrying out CT beyond the 4 h period does not result in significant detriment to outcomes.

1430

A comparative evaluation of radiographs, CT and 3D imaging in facial trauma

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PURPOSE: It is thought that clinicians respond more readily to radiographs and 3D images, whereas radiologists obtain more from CT images. We have carried out an objective evaluation of this perception. METHODS: Imaging records were selected from 16 patients with acute facial trauma, over a 2 year period. Patients had undergone radiography, high resolution CT and 3D reconstruction using a stand-alone processing unit and in-house software. Seven radiographs, nine CT studies and seven 3D images were selected by panel consensus, to represent the full range of facial fractures. A standardized viewing format was created by video transfer of single radiographs, selected CT sections and 3D images in rotating frame. The video tape was then displayed under standardized conditions to an audience who were asked to record by questionnaire their evaluation of 19 objective signs. Viewers were also asked to record their subjective comparison of the modalities. Responses were marked against a "gold standard" reading by the radiologist and surgeon responsible for management of the patients. RESULTS: There are clear and measurable differences in viewers' evaluation of radiographs, CT and 3D images. This effect applies selectively to different diagnostic criteria. The results may indicate training differences between surgeons and radiologists. CONCLUSION: This study has confirmed objectively the current view of the acceptability of 3D images to clinicians. The reasons for this are discussed.

1440

Nurse practitioner radiograph requests: a comparison of positivity rates with those of junior doctors

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PURPOSE: In many A&E departments nurse practitioners are able to make requests for radiography. We compared the positive hit rate of these requests with those made by the A&E SHOs. METHODS: 200 radiographs done for minor trauma were reported for evidence of bony trauma or for radiopaque foreign body. These comprised an equal number requested by nurse and junior doctor. The positive hit rate from each group was compared. RESULTS: The nurses had a positivity of 49% and the doctors 47%. CONCLUSION: In our department pick up rates are similar whether the radiographs are requested by the nurse practitioner or by the junior doctors. Concerns that nurse requesting would result in either under- or over-utilization of the Radiology department are unfounded.

1450

Is there a role for formal reporting of A&E radiographs?

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PURPOSE: To assess the role of formal reporting (by a specialist registrar and/or consultant in radiology) of radiographs taken on patients attending an Accident & Emergency (A&E) department which treats approximately 50,000 patients annually. MATERIALS AND METHODS: Over a 2 month period patients in which there was discrepancy between the initial and official X-ray reading were identified from radiology records and the A&E recall logbook. Patients' notes were reviewed to correlate clinical details with the radiographs. A missed fracture was deemed as one not seen in the initial reading, but detected later by the radiologist. Questionable fractures were not included if the clinical history and examination did not match up with the detected abnormality or if repeat radiographs were normal. RESULTS: Missed fractures (with numbers of cases) involving the upper limb included radial neck (2), distal radius (2), triquetral (2), scaphoid (1), trapezium (1), hamate (1), metacarpal (3), proximal phalanx (3), proximal interphalangeal joint volar plate (2) and terminal phalanx (3). Lower limb fractures included tibial plateaux (1), Segond (1), lateral malleolus (3), calcaneum (2), metatarsal (2) and phalanges (2). CONCLUSION: In this preliminary study over a short time period, 31 missed fractures (of variable clinical significance) were detected by a radiologist subsequently reviewing the radiographs. Close co-operation between A&E and radiology departments is essential to ensure appropriate patient management.

1500
Radiographic misinterpretation by casualty staff
P Davison, L Hare, M Lavender and C Wakeley
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Interpretation of radiographs by casualty staff is an important process in patient management. Errors occur because of the large volume and wide spectrum of radiographs involved and the relative inexperience of junior casualty staff. In most departments "hot" casualty reporting is not practical. PURPOSE: To study these errors and attempt to improve performance, a prospective audit was conducted at the Bristol Royal Infirmary casualty department over an 11 week period. The audit standard adopted after literature review was that "80% of radiographic abnormalities should be identified by casualty staff". METHOD: All musculoskeletal radiographs were included in the audit. Casualty staff placed a green dot close to, but not obscuring, any abnormality identified. The reporting radiologist noted the presence of the dot. Clinical notes were correlated with the report and the presence or absence of a true abnormality noted. RESULTS: 871 musculoskeletal radiographs were included, 475 of which were abnormal based on the radiologist's report. Casualty staff had a false positive rate of 15.2% and a false negative rate of 5.9%. The overall error rate was 10.1%. The majority of radiographs misinterpreted were of the distal appendicular skeleton (hand, foot or ankle). CONCLUSION: The error rates recorded by casualty staff were within the audit standards and comparable to other studies. The main source of error was identified as misinterpretation of skeletal structures in the hand, foot and ankle. It is suggested that the process be re-audited following a period of appropriate education to determine whether the error rate can be improved.

1510
Ankle trauma: what is the best radiographic approach for associated midfoot injuries?
R Bramley, J S Tuck and R W Whitehouse
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PURPOSE: To determine if routine inclusion of the midfoot on ankle trauma radiographs is justified. METHODS: 100 ankle radiographs were assessed to determine how consistently the midfoot region is included on standard projections. Over 16,000 radiology reports were reviewed to identify all the midfoot fractures along with the radiographic series performed. The relative merits of ankle and foot radiographic series were assessed by inspection of 25 midfoot tarsal fractures and 30 fifth metatarsal fractures. RESULTS: Ankle radiographs did not routinely include the whole of the midfoot (29% of lateral and 67% of frontal projections were not inclusive). Nevertheless, 8 of 161 midfoot fractures were discovered when only ankle radiographs had been taken, and 7 of 10 navicular fractures were only seen on the lateral ankle radiographs when both ankle and foot series were performed. Annually, over 1,000 patients had both ankle and foot radiographic series taken. All clinically significant fractures were seen on the ankle radiographs when the midfoot was included on both frontal and lateral ankle projections. CONCLUSION: Both AP and lateral ankle views must include the midfoot and base of the fifth metatarsal. This can be achieved with a modified frontal ankle view taken in plantar flexion and by extending the lateral ankle projection anteriorly. This study indicates that initial assessment of patients with ankle trauma may then be made without the need for additional foot radiographs. The proposed changes will assist in the detection of midfoot fractures and significantly reduce the number of radiographs currently taken.

1520
Discussion

1400–1530
Hands on Workshop
Vascular Imaging in Ultrasound
Hall 11A

1400
Invited Review
How to scan for deep vein thrombosis—a Magical Mystery Tour of calf veins
B A Sarker
Ultrasound Department, Queen Elizabeth Hospital, Gateshead, Tyne & Wear NE9 6SX, UK
Historically, the research papers published on scanning for deep vein thrombosis (DVT) in the lower limb have quoted variable sensitivity and specificity dependent on scanning technique, use of multiple modalities, operator experience, etc. A particular area of difficulty has been the calf veins with opinion polarized with regard to ease of diagnosis of calf vein DVT and its value. As these papers have been produced, the technology of ultrasound equipment and increased skill of general sonographers in vascular techniques may have superseded the literature. Today, I hope to demonstrate to you how quick and easy a complete evaluation of the deep veins of the leg is, with practical tips on how to improve your own personal sensitivity and specificity and also how to avoid common pitfalls. Some of the points that will be addressed in this Hands On Workshop follow: (a) use of pulsed Doppler in the groin to exclude occlusive iliac vein thrombosis; (b) compression sonography in the proximal limb with the use of a curved or low frequency linear probe to avoid missing thrombus in paired venous variants and in the larger patient; (c) popliteal fossa pathology and introduction to the gastrocnemius veins; (d) calf veins – anterior and posterior tibial and peroneal and their identifying landmarks; (e) accessory calf veins and venous sinuses of the lower limb; (f) identification of partially occlusive calf vein thrombus and popliteal extension of calf DVT using colour Doppler; (g) set-up optimization for DVT and in the technically challenging patient; (h) optimizing patient position for the student and for reality! I also hope to commend to you the value of a complete examination further to that required for the immediate clinical diagnosis and to show you why examination of the calf veins is the basic building block for other vascular scanning techniques.

1425
Invited Review
Carotid Doppler
O M Clarke
KeyMed, KeyMed House, Stock Road, Southend on Sea, Essex SS2 5QH, UK
The purpose of this talk is to demonstrate the technique of ultrasound evaluation of the extracranial neck arteries, providing tips and highlighting pitfalls of this examination. Initially the anatomy and associated disease processes of the carotid arteries will be reviewed followed by an explanation of the Doppler technique together with interpretation and significance of the results. Duplex and colour flow Doppler of the carotid vessels is a non-invasive examination and an accurate means of detecting significant stenosis in the internal carotid artery. Carotid Doppler plays a valuable part on the surgical and clinical evaluation of these patients.

1450
Invited Review
Duplex ultrasonography is useful and valid in the diagnosis and assessment of lower-limb vascular disease
Y Morarji and N Tai
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Colour-coded duplex Doppler ultrasound is a cost-effective, non-invasive method of obtaining accurate anatomical information when assessing vascular stenoses via colour and spectral waveform analysis plus measurement of peak systolic velocity (PSV) values and ratios. Additionally, duplex arteriography provides important quantitative haemodynamic information, which contrast arteriography does not. Studies show that, compared with contrast angiography, duplex scanning has a sensitivity of 82% and a specificity of 92% when used to diagnose the significant stenoses, with positive and negative predictive values of 80% and 93% respectively. Colour coded Doppler has been validated in the selection of patients suitable for percutaneous transluminal angioplasty (PTA) of lower-limb stenoses. Furthermore, duplex scanning performed immediately after PTA allows immediate verification of flow restoration, whereas conventional contrast angiograms may appear normal despite residual flow disturbances. Duplex ultrasonography is now indispensable as the primary method of assessing infrainguinal vascular bypass graft function. Earlier detection of failing Dacron, Gore-Tex or autogenous vein grafts enables prompt surgical/endovascular intervention and increased prospect of limb salvage. Moreover, the decision to utilize autogenous vein is now commonly influenced by pre-operative duplex assessment of lower-limb superficial veins. With advances in curvilinear probe design the proximal vasculature is increasingly accessible to Doppler studies, and iliac artery stenoses are identifiable with sensitivity of 89% and specificity of 90%. Allied to ongoing developments in the training of vascular technologists, such improvements will permit the refinement of current practice and the development of new applications for duplex ultrasound in the management of lower-limb vascular disease.

1515
Discussion

MONDAY

1400–1515
State of the Art Symposium
Update on Radionuclide Imaging
Hall 11B

1400
Invited Review
Radionuclide diagnosis and therapy of cancer
K E Britton
Nuclear Medicine Department, St Bartholomew's Hospital, London EC1A 7BE, UK
Nuclear medicine now exploits the subtle differences between the cancer cell and the normal cell to add specificity to its well known sensitivity. This identification of cancer by tissue characterization means that, unlike in radiology, cancer tissues do not have to be in the form of a mass. Ribbons and plaques of cancer are able to be imaged. The main new agents are radiolabelled peptides and monoclonal antibodies, their fragments and genetically engineered derivatives. The biological edge of the tumour often exceeds its apparent physical edge seen by CT or MRI. Positron emission tomography and SPECT coincidence counting with ^{18}FDG is demonstrating disease in the less than one centimetre diameter lymph node. Targeting of radionuclide therapy with beta and even alpha emitting radionuclides has progressed from the principles well accepted for the treatment of thyroid cancer. Techniques include direct injection into tumour sites, intraarterial treatment of liver metastasis, intravenous therapy of B cell lymphoma with ^{131}I BI (which gives complete remissions in 25% of these patients in whom recurrence has occurred in spite of all other therapy), yttrium-90 labelled Lanreotide for gastroendocrine malignancies, two and three stage targeted therapy for sited tumours. Nuclear medicine is beginning to realize its potential for cancer specific diagnosis and therapy.

1430
Invited Review
Imaging occult infection and pyrexia of unknown origin
A M Peters
Department of Imaging, Hammersmith Hospital, Du Cane Road, London W12 0HS, UK
Occult infection and PUO are clinical entities which together comprise the clinical spectrum of undiagnosed fever. Patients presenting with undiagnosed fever generally fall into two broad groups: firstly, those with co-existing disease or recent surgery, and secondly those with pyrexia but who are otherwise well. A pyogenic cause for fever is significantly more likely in the first group, which may therefore be described as occult infection, as compared with the second which may appropriately be called pyrexia of unknown origin (PUO). Radionuclide agents which are currently available for investigating undiagnosed fever are labelled leukocytes, ^{67}Ga, and radiolabelled human immunoglobulin (HIG). Since a pyogenic cause of fever is more likely, labelled leukocytes are generally preferable in occult infection, whereas ^{67}Ga should be used first in PUO. The lower specificity of ^{67}Ga is an advantage in PUO in view of the wide range of pathologies capable of causing PUO, including malignancies, which are more likely to accumulate ^{67}Ga than leukocytes. The role of HIG in undiagnosed fever requires further study. In general, ^{67}Ga is more helpful than labelled leukocytes when the cause of PUO is intrathoracic, although the reverse is likely to be true for intra-abominal causes, partly because of physiological excretion of ^{67}Ga in the gut. Post-operative fever is an indication for a leukocyte scan. Patients with haematological malignancies occasionally present as PUO, but patients with chronic renal disease should be approached as occult infection. Investigating children with undiagnosed fever is a particularly difficult problem. For the future, we need agents which are particularly effective for localizing chronic inflammation and, of secondary importance, agents able to distinguish between infective and non-infective causes of inflammation.

1500
Discussion

1400–1515
Scientific Session
*info*RAD™—Implementing a PACS
Olympian Suite

1400
Invited Review
Implementing a PACS
Y Rees
Radiology Department, Leicester General Hospital NHS Trust, Leicester LE5 4PW, UK
It is firstly important to understand exactly what PACS involves. This will require much background work including visiting sites with PACS *in situ*. The advantages and disadvantages of PACS must be understood. Contracts must be concise and very specific. The implementation of PACS both in the radiology department and throughout the hospital involves considerable changes in work practice, with corresponding training issues. Contingency plans must be in place prior to the start of the PACS. An overview of the department and the hospital is necessary. Although there are considerable pitfalls with the implementation of PACS, the benefits outweigh the difficulties.

1430
Teleradiology—its role in urban and rural Australia
R P George
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Teleradiology has had a long but widely disparate application in Australia. Dr Jones & Partners is a very large private radiology practice based in Adelaide, South Australia, and as well as having over 20 suburban hospital and private clinic outlets, the practice services three major rural hospitals up to 3 h flying time from Adelaide. These sites include CT and Doppler ultrasound facilities. Our experience with teleradiology includes not only regular usage between our suburban outlets but also offering radiological support to these outlying, remote centres. More recent focusing of teleradiology has seen an interesting application in South Australia. A co-ordinated programme has seen our remote rural sites linked not only to our main private practice locations but also either directly or indirectly to major teaching hospitals, providing 24 h support for neurosurgical, orthpaedic and obstetric tertiary patient management support. Selection of the equipment used will be discussed and examples of specific case studies outlining the benefits of this network will be presented.

1440
A low cost telemedicine facility for general practice
M R Rees and M S N Murthy
Division of Clinical Radiology, University of Bristol, Bristol BS2 8HW, UK
PURPOSE: To develop a low cost teleradiology and telemedicine facility to link a base hospital and general practice. MATERIALS AND METHODS: Standard computing equipment and software were used throughout. Base hospital: 166 MHz Pentium computer with 32 Mb of RAM, a SCSI interface with a CD writer/player, PCI card desktop CCD camera with a 17 inch monitor. Images were digitized using an 8 bit Cobrascan at 9600 DPI. General practice: 333 MHz P2 computer with 128 Mb of RAM, CD writer/reader, CCD camera, desktop scanner with transparency adapter, 21 inch monitor. Phone communication used ISDN 2 and PSTN lines. Software included whiteboarding and PC anywhere. Images were scaled down to 25% of normal prior to transmission at 128 kb s^{-1}. Films and reports for 50 clinics were sent from the base hospital to an orthopaedic clinic at the general practice with an average of 12 patients per clinic. Dermatology and chest X-ray images were also transferred. RESULTS: All images transmitted were of acceptable quality for the doctors involved to complete the clinical process. The telemedicine link proved to be a viable alternative to sending films and images by post which had been the previous practice. The transmission of clinical images proved to be a useful pilot for the speeding up of hospital referrals. CONCLUSION: We have demonstrated that a low cost solution for telemedicine and

teleradiology links between hospital and general practice can be achieved using standard computing equipment and software.

1450
A strategy for the recording and presentation of medical images in radiological multimedia reports
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Many clinicians who request radiological services have come to expect appropriate images to accompany reports. The recent interest in the implementation of the Electronic Healthcare Record implies the need for the development of viable strategies for the production of multimedia radiological reports. The production of hardcopy images to accompany radiological reports on paper forms an important part of the radiographer's work. This paper investigates the properties of a multimedia radiological report much of which can be prepared in advance of the reporting session by the radiographer and can be presented as a navigable hypertext document similar to those currently accessible via an Internet Web browser or in multimedia video form. Such a prepared hypertext document would include the request details, a description of the radiological procedures as performed and a description of the results with links to the relevant images and graphical annotation specified by "container" objects. The reporting clinician would view this material, adjusting windowing as appropriate, and then record the interpretation and clinical advice, possibly adding further annotation. A multimedia record would then be created which specified the start time and duration of the presentation of the various container contents in sets of areas within a display window.

1500
Discussion

1530–1715
Scientific Session
Tumour Imaging
Hall 8

1530
CEA immunoscintigraphy in the investigation of colorectal cancer recurrence
[1]W M Nelson, [2]P Lee, [2]J R T Monson and [3]G R Avery
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PURPOSE: The effective non-invasive detection of early recurrent disease in colorectal cancer can maximize the benefit of subsequent patient therapy. We investigated the radiological yield and clinical outcome of the first 25 patients undergoing technetium-99m labelled anti-CEA monoclonal antibody imaging. METHODS: 25 post-surgical colorectal cancer patients (6 females, 19 males, age range 46–83 years) had their $^{99}Tc^{m}$ anti-CEA monoclonal antibody (Mallinckrodt) scans, case notes and cross-sectional imaging (CSI) retrospectively reviewed. The CEA scans were performed using a standard protocol to evaluate cancer recurrence. All patients had both planar and SPECT imaging obtained at 4 h after iv injection of the monoclonal antibody fragment. RESULTS: To date, assessment of 25 cases has yielded 4 cases of pelvic recurrence (3 on imaging grounds and 1 proven histologically). There was no pelvic recurrence in a further 17 cases confirmed at CSI. In the remaining 4 cases, 2 had iliac lymph node involvement not demonstrated on initial CSI (but subsequently confirmed) and there was 1 false positive case of pelvic recurrence and 1 technical failure due to excessive patient movement. Of these successful cases the location of liver metastasis was confirmed in 7 cases, of which 3/7 cases were identified as cold deposits. However, 6 cases failed to identify known liver metastasis. CONCLUSION: $^{99}Tc^{m}$ anti-CEA monoclonal antibody scans produced high quality imaging, helped establish whether pelvic recurrence had developed and provided important additional information, particularly in the pelvis where CSI interpretation can be difficult in post-colorectal surgery patients.

1540
Dynamic contrast enhanced MRI fails to differentiate malignant from benign lesions in recurrent colorectal adenocarcinoma
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The goal of this study was to determine if dynamic contrast enhanced MRI would allow the diagnosis of soft tissues masses observed subsequent to resection in patients treated surgically for colorectal adenocarcinoma. 54 patients were investigated after resection of their primary lesion, of these 14 had received prior radiotherapy. Multiple slice dynamic imaging was performed at 1.5 T (GE Signa Echospeed) using a T_1-weighted FSPGR sequence. Dimeglumine gadopentetate (0.1 mmol/kg body wt) was injected intravenously during the third acquisition and scanning continued for a further 5–8 min, resulting in 25–35 images with a temporal resolution of 10 s. The time course of signal intensity within specific ROIs encompassing the whole lesion was analysed, using a two-compartment pharmacokinetic model, to provide estimates of permeability (PSAP) and distribution volume (Vec). Subsequent biopsies of 31 patients demonstrated 19 malignant and 12 benign lesions. A further 3 malignant lesions were identified from long-term radiological follow-up. Pharmacokinetic analysis of lesion time–intensity curves did not reveal any significant differences in maximum enhancement (MaxEI), PSAP or Vec between the malignant and benign groups ($P > 0.5$ for all cases). This situation was not changed by exclusion of patients treated by radiotherapy nor by restriction of the analysis to biopsy proven lesions. In all comparisons the mean parameter value and its standard deviation were greater for malignant lesions than for benign. Further analysis demonstrated that MaxEI was correlated to both Vec and PSAP for both benign and malignant lesions, suggesting that uptake of contrast agent may be severely limited by low perfusion. This investigation was supported by Yorkshire Cancer Research.

1550
PET scanning in carcinoma of the oesophagus
[1]R J Chambers, [2]W L Wong, [2]J Lowe and [1]E R Townsend
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PURPOSE: Prognosis in carcinoma of the oesophagus remains unpredictable and poor with all modalities of treatment, including surgery and/or chemo-radiotherapy. The aim of this study was to perform PET imaging in patients referred for possible surgery in biopsy-proven Ca oesophagus; the contribution of PET findings was then assessed to determine if selection for surgery could be refined, so improving long-term survival. METHOD: 50 patients with biopsy-proven Ca oesophagus had PET imaging, together with CT scan and barium studies; ultrasound liver and bone scans were performed on some patients where considered necessary. These findings were correlated with findings at surgery, and with detailed studies of pathological specimens. RESULTS/CONCLUSION: PET imaging contributed significantly to the selection of patients for surgery. PET imaging revealed liver, bone and lung metastases not identified on other studies; more specific information concerning lymph node involvement was also obtained. PET imaging therefore contributed significantly to selection of patients for surgery.

1600
Metal stenting for malignant oesophageal dysphagia—5 years experience in 100+ patients
I G H Renwick, J D Harrison and C Wilson
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PURPOSE: To review the effectiveness, subsequent management and complications of metallic stenting in over 100 patients with inoperable malignant oesophageal or oesophago-gastric obstruction. METHODS: A mixed retrospective and prospective study of over 100 patients following insertion of a metallic oesophageal stent, the vast majority being covered Gianturco-Rosch stents. Pre- and post-procedural dysphagia scores were recorded as well as the actual quality of diet achieved by the patients independent of dysphagia scores. All patients were followed up by a Macmillan nurse with close links to the radiology department and this provided a more realistic appraisal of quality of life. Complications, both immediate and delayed, were reviewed. RESULTS: Successful stent deployment was achieved in all cases with complications being extremely rare. Stent displacement occurred in a small number of patients and its management will be discussed. Encouragement of patients back

to a normal diet early seemed to result in better long term dietary histories. CONCLUSION: Metallic oesophageal stenting is an effective palliation for inoperable malignant dysphagia with few complications but follow up by a dedicated nurse can help overcome psychological and dietary difficulties.

1610

Endoscopic ultrasound guided transoesophageal biopsy of sub-carinal lymph nodes

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Sub-carinal lymph nodes can be difficult to access percutaneously but tissue obtained may alter patient management. We describe our initial experience of endoscopic ultrasound (EUS) guided transoesophageal fine needle aspiration in 10 patients. Following sedation, the EUS probe (Hitachi/Pentax) is passed into the oesophagus and the sub-carinal nodes located usually at around 30 cm from the incisors. A 22G Hanke-Villmann needle is passed into the node through the oesophageal wall under ultrasound guidance. The needle stylet is removed, 10 ml of suction applied and the node widely sampled. Slides are prepared from the aspirates and any solid matter is processed for cell block. The procedure takes about 10 min. The main role has been diagnosing malignancy, and determining the type of malignancy, particularly when bronchoscopic or percutaneous biopsies have been unhelpful. In 8/10 cases, malignancy was confirmed and the cell type determined (small cell/non-small cell). The diagnostic failure in one case may be related to the effects of radiotherapy. In the remaining case of known abdominal non-Hodgkins lymphoma, the FNA contained numerous lymphocytes. There were no complications. To our knowledge we are the first group in the UK to perform this technique, which has already altered our patient management.

1620

CT assessment of ovarian tumour masses prior to surgery

S Swift, J A Spencer, R Clayton, D Wilson, N Wilkinson, G Lane and S Wong

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PURPOSE: Excision alone is appropriate for most benign ovarian masses but for malignant lesions radical cytoreductive surgery may be required. In this study we have assessed the ability of CT to distinguish between benign and malignant lesions, comparing a morphologically based scoring system with subjective impression of experienced radiologists. METHODS: 68 consecutive women (age range 27 to 87 years) with ovarian masses resected by the same experienced gynaecological oncologist underwent pre-operative contrast-enhanced CT. These were retrospectively analysed by two independent radiologists blinded to clinical details. The masses were rated using a modified version of Lerner's ultrasound based morphological scoring system (range 0 10) with two defined benign/malignant cut off scores of >2 and >3 compared to a five point subjective assessment of benignity *vs* malignancy. All lesions were assessed by the same specialist pathologist. Borderline lesions were included with malignant for the analysis. RESULTS: 31 lesions were benign, 8 borderline and 29 malignant. Using ROC analysis, the overall accuracy of subjective assessment was greater than the morphological score with areas under ROC curves of 0.82 and 0.74 respectively, although this was not statistically significant. Subjective assessment was significantly better for identifying benign lesions *vs* morphological score at either cut off. Morphological score had improved sensitivity for malignant lesions at a cut off of >2 *vs* >3 or subjective assessment. CONCLUSION: CT impression proved superior to scoring systems in the diagnosis of benign lesions but CT consistently misdiagnosed benign solid adnexal lesions such as fibromyomata. There is still considerable difficulty in the distinction of complex benign from stage I borderline and malignant lesions even with modern CT equipment.

1630

Evaluation of adrenal masses using F-18 fluorodeoxyglucose PET and SPECT imaging

K Sandrasegaran, M C Estrada and R Burt

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PURPOSE: To evaluate the ability of PET and SPECT imaging with F-18 fluorodeoxyglucose (FDG) in differentiating benign from malignant adrenal masses. METHOD/MATERIALS: CT records from all patients who had PET and/or SPECT whole body imaging performed at Indiana VA Medical Center during the 5 year period to March 1998 were reviewed for evidence of an adrenal mass. Cases selected for this study had reasonable proof (tissue verification or CT follow-up to assess stability) of the cause of adrenal enlargement. PET and SPECT cases were read independently of the CT or pathological findings. RESULTS: There were 19 patients (all male, mean age of 66) with 23 adrenal masses. There were 5 malignant and 18 benign adrenal lesions. Of 14 adrenal lesions imaged with PET, PET correctly identified 2 of 2 malignant and 12 of 12 benign lesions. Of 15 adrenal lesions imaged with SPECT, SPECT correctly identified 3 of 3 malignant and 12 of 12 benign lesions. 5 patients (6 lesions) had both PET and SPECT. CONCLUSION: Both PET-FDG and SPECT-FDG imaging are able to differentiate benign from malignant adrenal masses. SPECT FDG imaging is a useful cheaper alternative to PET-FDG imaging of adrenal masses.

1640

CT guided peritoneal biopsy with immunohistochemistry cytokeratin analysis for primary site diagnosis in peritoneal carcinomatosis

S Swift, J A Spencer, N Wilkinson, A P Boon, G Lane and T J Perren

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PURPOSE: To assess the utility of CT guided peritoneal biopsy in determining the primary malignancy in women with peritoneal carcinomatosis (PC) of unknown origin. To compare the value of cytological analysis of ascites with histological assessment that included immunohistochemistry analysis. METHOD: 15 women (age range 47–85 years) were studied; 11 were considered unfit for exploratory surgery and CT had failed to show a primary tumour site; 4 had previous tumours known to metastasize to the peritoneal cavity (3 breast, 1 colon). CT guided biopsy included fine needle aspiration cytology from ascites when present, followed by 18G cutting needle biopsy cores using a spring loaded device. Biopsy sites included omental cake (10), peritoneum (3) and adnexae in 2 cases with prior breast malignancy. Immunohistochemical analysis of the core material was performed with monoclonal antibodies to CEA-M, CA 125, cytokeratin 7 (CK7) and CK20. Cytologic and histologic analysis were reported by independent pathologists. RESULTS: Cytologic analysis was diagnostic of adenocarcinoma of no specified site in 7 cases and probable non-ovarian origin in 2 cases. Core biopsy material was diagnostic of a primary site in all 15 cases. Sufficient material was available from core biopsy for a full panel cytokeratin analysis in 13 of 15 (87%) cases. On the basis of morphology, primary site diagnoses were: ovary 8 cases, large intestine 3, breast 1 and poorly differentiated cancer of uncertain site 3. Cytokeratin analysis supported a primary ovarian or peritoneal origin in these 3 cases (CK7 +ve, CA 125 +ve) and provided further diagnostic confirmation in the other cases. CONCLUSION: In this prospective pilot study, CT guided peritoneal biopsy provided sufficient material to establish a primary site diagnosis in PC. The technique offers a minimally invasive method to guide management of PC, particularly when radical surgery is not an option or where there is a history of a primary tumour recognized to metastasize to the peritoneum.

1650

Imaging of neuroendocrine tumours: does 3D registration of CT and Octreoscan SPECT data improve diagnostic accuracy?

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OBJECTIVE: To assess whether spatial registration of CT with Octreoscan SPECT data is of additional diagnostic benefit in the localization and staging of neuroendocrine tumours, and to assess the potential effect on patient management. METHOD: Patients with known neuroendocrine tumours underwent Octreoscan (indium-111 pentetreotide) planar and SPECT imaging and contrast enhanced spiral CT. The SPECT and CT data volumes were spatially registered using fiducial markers (Nycomed Amersham Ltd) which were both radiopaque and radioactive. A contour based registration method was employed using Analyze AVW. Spatial registration enabled more accurate anatomical localization of any abnormality seen on Octreoscan. RESULTS: Registration provided additional information and in some cases led to an alteration in patient management. CONCLUSIONS: Registration of Octreoscan SPECT and CT data improves diagnostic accuracy and may therefore influence management of neuroendocrine tumours.

1700

Discussion

1530–1730
Scientific Session
Vascular Imaging and Intervention 2
Hall 11B

1530
Risk factors for the embolizing carotid plaque

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AIMS: To determine the degree of cerebral embolization, using cranial computed tomography, in a cohort of patients prior to undergoing carotid endarterectomy (CEA). The degree of embolization was correlated with the plaque analysis (the presence of *C. pneumoniae*) and morphology (stenosis and echogenicity). METHOD: 91 symptomatic consecutive patients were recruited. All patients underwent a pre-operative cranial CT scan. Further pre-operative imaging included transcranial Doppler (TCD) of their ipsilateral middle cerebral artery for 30 min 24–48 h before surgery. Intraoperative TCD recordings were made from the MCA and the degree of embolization during the procedure was recorded. Plaque morphology and stenosis was assessed using ultrasound scanning. The presence of the Chlamydial DNA was detected using a nested polymerase chain reaction test. RESULTS: 91 patients with a mean age of 69.5 years were assessed. 12 of the patients were found to be embolizing preoperatively by TCD and 31 patients embolized during the dissection of the carotid artery prior to clamping. 27 of the plaques were positive for *C. pneumoniae*. Analysis of the CT scans demonstrated no significant differences in the number of ipsilateral hemispheric infarcts between the preoperative group of embolizers and the non-embolizers, but there was a significantly greater number of infarctions ($p=0.02$) when the intraoperative embolic events were included. Other factors including age, sex and morphology will be discussed. CONCLUSION: There was no significant difference between CT infarction in preoperative embolizers and non-embolizers. The ultrasound scanning data suggest that younger male patients with echolucent plaques are significantly more likely to embolize preoperatively. Furthermore, the presence of *C. pneumoniae* does not affect the observed embolization.

1540
Audit of intra-arterial thrombolytic therapy at Blackburn Royal Infirmary

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PURPOSE: This retrospective audit was undertaken to examine the results of intra-arterial thrombolytic therapy for acute lower limb ischaemia at a district general hospital. There was concern that too few procedures were performed to provide a safe and effective service. MATERIALS/METHODS: Between October 1993 and March 1998 there were 32 events of primary thrombolysis in 30 patients (20 male, 10 female) aged 38–87 years (median 69). In 18 cases, native arteries were thrombosed and in 12 cases synthetic grafts. There was one case of a thrombosed popliteal aneurysm and one case of thromboembolism complicating angioplasty. A low dose infusion of streptokinase was used in all but three cases in whom recombinant tissue plasminogen activator was used. The procedures were performed by four of six consultant general radiologists. RESULTS: At 30 days the primary and secondary limb salvage rates were 18/32 (56%) and 22/32 (68.7%) respectively. Six (18.8%) were alive following a major amputation and four (12.5%) were dead. Major complications affected seven patients including one fatal retroperitoneal haemorrhage, two non-haemorrhagic strokes and four groin haematomas requiring transfusion or evacuation. Most of these complications occurred early in the series. CONCLUSION: This audit shows that, despite the infrequent referral for thrombolysis, acceptable results can be achieved. Limb salvage rates compare well with other series using streptokinase.

1550
Treatment of malignant inferior vena caval obstruction with metallic stents

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PURPOSE: To assess the role of metallic stents in the treatment of malignant inferior vena caval obstruction. METHODS: 5 cases of malignant IVC obstruction have been treated with metallic stents and subsequently followed up in the local hospice. RESULTS: Technical success was achieved in all patients. Significant reduction in oedema occurred in 4 patients but a number of significant complications were encountered. These will be discussed and suggestions made for their avoidance or treatment. CONCLUSION: Metallic stents do have a place to play in malignant obstruction of the inferior vena cava but the procedure is not without significant complications. Patients with advanced, pre-terminal malignancy have less to gain from palliative stenting.

1600
Visualization of blood flow with phase inversion tissue harmonic imaging

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PURPOSE: Tissue harmonic imaging (THI) has been shown to improve the contrast resolution and spatial resolution in medical ultrasound images. The phase inversion technique for acquiring THI images used on the Siemens Sonoline Elegra provides an excellent method of removing fundamental frequency echoes while maximizing spatial resolution and sensitivity. An additional benefit of the phase inversion THI technique is the ability to enhance the visualization of blood flow. METHOD: The signal processing that allows phase inversion THI to differentiate between static and moving targets is described. The influences of the blood velocity, direction of flow, system parameters, as well as the relative amplitudes of the moving blood and of the stationary harmonic echoes from tissue are investigated. RESULTS: Theoretical analysis of the axial and lateral flow components in THI images is presented. *In vivo* and phantom THI images of flow are acquired. Pulse wave Doppler is used to quantify the flow velocities in these images. CONCLUSIONS: In addition to enhancing spatial resolution and contrast resolution in tissue, the phase inversion THI technique provides new information about the motion of blood that previously was available only through the use of Doppler imaging techniques.

1610
Malignant superior vena caval obstruction: stenting via the subclavian approach

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PURPOSE: To describe and demonstrate the efficacy of the percutaneous subclavian approach as preferred access for stenting of symptomatic malignant superior vena cava obstruction (SVCO) with the self-expanding Wallstent endoprosthesis. MATERIALS AND METHODS: 21 of 29 patients (age range 26–89 years) with malignant SVCO referred for interventional management over a 2 year period were treated with the self-expanding Wallstent via the subclavian route. Histology was available in all patients. Intraluminal tumour ingrowth was seen in four cases. The majority had a 14 mm Wallstent placed with a short delivery device. In only three was a second device placed. A stent was used to exclude thrombus in the contralateral brachiocephalic vein ($n=4$). Retrospective analysis of the clinical records was used to assess symptom free survival and symptom recurrence. RESULTS: All patients reported an improvement in symptoms within 24 h of the procedure. Complications in the subclavian group included single cases of early post-stent thrombosis, forward migration on deployment and on balloon dilatation. Technical success was achieved in 100%. Clinical success (freedom from symptom recurrence) was obtained in 18 out of 21 patients to death (range 1–34, mean 15 weeks) with one re-intervention. The majority of referrals were for primary placement ($n=13$). CONCLUSIONS: The subclavian approach is our preferred access route and provides greater local control of the "short delivery" Wallstent device with no increase in complications. We now recommend this approach as the preferred access route.

1620
Endovascular stenting: our experience with a new stent and the use of non-invasive surveillance

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Ilio-femoral atheromatous lesions are commonly seen in patients undergoing angiography for symptomatic vascular disease. An increasing number of this group of patients are undergoing primary stenting. We present our experience with the new "Symphony" stent (Boston Scientific) used over the period January 1997 October 1998, with complete follow-up through non-invasive means.

METHOD: 30 stents were placed in 21 patients (14 male and 7 female) with an average age of 61.3 years. Patients were clinically grouped according to the Rutherford classification and given a Brewster grouping dependent on the extent of their multi-segmental disease. RESULTS: Stents were successfully placed in all patients with good angiographic appearance and no technical complications. Outcome was assessed by clinical follow-up, ABPIs and Doppler ultrasound. Over the period of stent surveillance there were 4 deaths, all of which were in patients with high Rutherford and Brewster classifications. Of the remaining 17 patients, there was 100% primary stent patency with a range *in-situ* from 16 to 626 days with a mean value of 252 days. This was confirmed by an improvement in clinical symptoms and the mean ABPI rising from 0.34 before stent placement to 0.84 at follow-up. Doppler ultrasound showed all individuals to have triphasic waveforms with no damping in their iliofemoral segments. CONCLUSION: The Symphony stent appears to be technically a good endovascular stent with excellent primary patency rates to date. Non-invasive stent surveillance through clinical follow-up, ABPIs and Doppler ultrasound appear to be effective, patient tolerable and efficacious in monitoring outcome.

1630

Should anticoagulation be stopped or reversed prior to venous intervention?

D J Sadler, R R Gray, L Shulman, J C Saliken and C B So
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PURPOSE: To determine the safety of venous intervention and the incidence of complications in patients undergoing venous interventional radiological procedures in the presence of prolonged bleeding times. METHOD: Data were collected prospectively for a 1 year period. There were 100 anticoagulated patients who underwent interventional radiological procedures requiring venous cannulation. 87/100 had documented prolonged bleeding times. There were 50 inferior vena-cavograms and filter placements (29 transfemoral, 21 transjugular) and 50 transfemoral pulmonary angiograms (PA) performed all in anticoagulated patients with thromboembolic disease. Venous access was achieved using real time sonographic guidance if performed by Fellows, Residents, or one staff member. RESULTS: Venous access was gained in all patients in all groups. There were 41/50 filter placements and 46/50 pulmonary angiograms performed in patients with prolonged clotting times in or above the therapeutic range. There were no cases of arterial puncture and no cases of venous bleeding either during or after the procedure. No other complications were recorded. CONCLUSIONS: Venous intervention in patients with therapeutic anticoagulation is safe with no complications in our series. There is no need to discontinue anticoagulant therapy in patients with life threatening thrombo-embolic disease. Real time sonographic guidance greatly facilitates venous cannulation and avoids inadvertent arterial puncture.

1640

Analysis of early failure of tunnelled haemodialysis catheters

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PURPOSE: Tunnelled haemodialysis catheters are increasingly placed by radiologists utilizing ultrasound guidance and fluoroscopic screening to ensure safe placement of optimally positioned catheters. The aim of this study was to determine the causes of early failure ($\leq$ 7 days) in our practice. METHOD: Data were prospectively collected for 578 radiologically placed tunnelled haemodialysis catheters. All catheters requiring removal were sent to radiology. The reason for removal was recorded in each case. Removed catheter tips were routinely sent for microbiological culture. RESULTS: 45 (8%) catheters were removed within 7 days of insertion. 4 (1%) of these had completed use. Of the 41 (7%) failed catheters, 5 (1%) were clotted, 12 (2%) had suspected infection, only 3 of which had a proven catheter related infection. 24 (4%) were removed for other reasons. In this group the most common reason was poor tip position ($n=7$) and catheters replaced over a guide wire in a fibrin sheath ($n=6$). Only 2 failed owing to poor tip orientation. Other reasons for failure were kinked/pinched catheters ($n=4$) and bleeding ($n=2$) including one exsanguination. CONCLUSION: By paying careful attention to catheter tip position, diligent search for fibrin sheath when catheter exchanges are made over a wire and by better investigation of presumed catheter infection our early failure rate could be halved.

1650

Assessment of the new Easy Wallstent in vascular stenting

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PURPOSE: Recently a modified vascular Wallstent on a new delivery system was introduced into clinical practice. We evaluated the clinical utility of the Easy Wallstent in vascular stenting. MATERIALS/METHODS: In 6 months, 36 Easy Wallstents were placed in 32 patients. 30 stents were implanted in the arterial and 6 in the venous system (21 in the carotid arteries, 2 in the subclavian arteries, 7 in the iliac arteries, 4 in large veins and 2 in dialysis shunt veins). RESULTS: The delivery system of the Easy Wallstent was easy to use, but there were some difficulties with removal of the catheter after delivery of the stent. After placement the Easy Wallstent looked like a tube with both ends inverted. It did not mould itself to the vessel wall even after balloon expansion. In 2 cases a second stent had to be placed to mould the first stent against the vessel wall. The inverted ends of the stent also led to prolonged mobility of the stent-catheter during delivery. We observed two punctures of a PTA balloon owing to the inverted ends of the stents and in 2 cases migration of the Easy Wallstent. Follow-up imaging after 6 months in 6 cases demonstrated that the shape of the stent had not changed. CONCLUSION: The change in the properties of the Easy Wallstent compared with the original vascular Wallstent has led to different behaviour during stenting. It seems to be preferable to have the original vascular Wallstent mounted on the new delivery system.

For Work in Progress contributions to this session see p. 90.

1545–1700
Scientific Session
Radiographers: Professional Development
Hall 11A

1545

Mentoring female undergraduate students into employment: a European community funded initiative

G A Marshall
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PURPOSE: This research studied the value of extending mentoring of third year female undergraduate student radiographers until employment was secured and the graduate became an established worker. MATERIALS AND METHODS: The Department of Radiography and Imaging Sciences, University College of St Martin (UCSM), Lancaster have traditionally mentored all students in clinical placement, via workplace mentors (radiographers). This process has never extended into the period when they take up employment. UCSM participated in a pilot scheme which was realized by financial support from the European Community via the Leonardo Da Vinci programme. Participating countries were Holland, Austria, Germany, Ireland and England. The project, LifeLOng MEntoring of Women (MELLOW) arose because the EC was concerned about the number of women entering careers in Science and Technology and the disappointing proportion that achieved high level positions. The MELLOW project had three parts. UCSM participated in Part B, which involved final year female undergraduates being mentored by an experienced employee (radiographer). RESULTS: Qualitative analysis showed that the experience had been valuable. All participants in the UCSM element of the project (5 mentor/student pairs) found the experience supportive. The students found the mentoring of benefit in coping with the rigours of final year study whilst concurrently seeking work. The subsequent transition into the world of work was eased. A matching protocol of mentors and students was written, mentoring training was given and a mentoring contract agreed. Subsequently a Good Practice Handbook was published by all the project partners. A bid is being considered by the EC to enlarge the project. CONCLUSION: Mentoring of final year female undergraduates over the time of their transition between university and employment is valuable.

1555
An investigation of clinical decision making in diagnostic radiography
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PURPOSE: To investigate the process of decision making in diagnostic radiography through the use of simulation techniques. MATERIALS AND METHODS: Diagnostic radiographers with a range of clinical experiences ($n=56$) were recruited. The study was restricted to southern England. No exclusion criteria were entered into the research protocol to ensure inclusion of a wide spread of abilities. Each subject was shown three video tapes of simulated imaging studies based on plain film musculo-skeletal examinations together with a request form for each study. While the videotapes were played subjects were encouraged to verbalize their thoughts or "think aloud". Each subject was audiotaped while they thought aloud and the tapes produced where used to form a verbal protocol for each subject. These were subsequently encoded and analysed independently by the two researchers for common themes. RESULTS: Encoding of the verbal protocols produced six recognizable levels of response to the clinical scenarios. These were: (1) description of the simulation without engagement; (2) observation of patient's condition; (3) re-iteration of information supplied - written, verbal and visual; (4) knowledge specific to radiography; (5) use of underpinning clinical knowledge; (6) comments specific to the radiographer in the simulation. Results showed that radiographers in the study made most comments in categories 4 and 5 with subjects combining understanding of clinical conditions with domain specific knowledge. Factors such as length of time qualified, age of subject or sex did not influence the verbal protocols produced. CONCLUSION: This study helps in understanding the thought processes of radiographers in clinical settings. This may have implications for education both for undergraduate studies and continuing professional development.

1605
A comparative study of the reporting accuracy of clinical radiographers and radiology registrars
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As part of the final assessment for the postgraduate diploma in Clinical Radiographic Reporting programme at the University of Salford, students undertook a final film viewing examination. The radiographs were compiled by four senior consultant radiologists and the diagnostic reports agreed. These radiographs were used to assess the plain film reporting accuracy of radiographers, and second and third year radiology registrars from a local training scheme, and a comparison between the three groups undertaken. METHOD: 45 sets of radiographs were categorized into easy; intermediate and subtle cases. The radiographs were then presented to the candidates in "stations", with five cases to view at each station. The candidates had to complete a pro-forma report sheet for each of the cases. This consisted of a tick box for normal/normal for age, normal variant or abnormal. If a candidate selected the normal variant or abnormal boxes they were expected to give written comments as to their findings. The papers were then assessed using a marking scheme that had previously been agreed by the four radiologists and the course leader. RESULTS: The mean scores were as follows: Group 1 (Radiographers) = 78.14; Group 2 (Third year radiology registrars) = 72.50; Group 3 (Second year radiology registrars) = 68.55. A one-way ANOVA identified a significant main effect of group. Post hoc analysis revealed a significant difference between Groups 1 and 3 ($p<0.02$). No significant difference was identified between the other groups. CONCLUSION: This paper will demonstrate that with relevant learning support, experienced and motivated radiographers can achieve a reporting accuracy comparable to that of third year radiology registrars.

1615
The development and implementation of a realistic, positive approach to Personal Performance Development Review
A J Kendrew and W E Brown
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PURPOSE: Royal Hull Hospital Trust has a universal Personal Performance Development Review (PPDR) scheme, used for all staff of all grades. As radiographers our departmental needs are great as are our own personal and professional development needs. Formal documentation of CPD evidence is becoming a necessity. We needed to utilize the PPDR scheme positively to identify realistic departmental and individual professional needs. METHOD: Reviewing the current PPDR scheme and realistically reviewing current departmental needs identified areas of staff development required to maintain and develop our high standard of service. Realistically reviewing departmental resources and available funding provided a basis for the implementation of a workable PPDR scheme. CONCLUSION: The conclusion will show that through the positive use of PPDR the resources available have been utilized to their maximum potential. All staff have been given the opportunity to complete professional postgraduate education and training (PET), in areas of personal interest, whilst maintaining the smooth running of a relatively small Radiotherapy Department.

1625
Evaluating CPD—can we make it effective?
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This research represents work undertaken as a PhD Thesis. Continuing Professional Development (CPD) is one of the priorities within imaging departments. All professions represented in the imaging department have a CPD policy, either mandatory (nurses and radiologists) or voluntary (radiographers) which is increasing the demand for resources to be invested in CPD as individuals collect "CME points" or "CPD hours" to record in their portfolios. Competition for limited resources will force individuals to justify any resource expenditure, yet no tool exists to effectively evaluate CPD activity or its impact. This study conducted 28 in-depth and 24 focused interviews with managers, radiographers, educationalists, nurses, physiotherapists, architects and representatives of the College of Radiographers and the Council for Professions Supplementary to Medicine (CPSM). The interviews were conducted across the UK and Florida (where CPD has been mandatory for radiographers for 14 years). Using thematic analysis, a model of CPD effectiveness has been created which identifies all the components which contribute towards the CPD process. By identifying all the contributory factors, individuals and managers can utilize the model to optimize CPD resource investment and consequently aim to increase the impact of CPD activity in the clinical environment. The model emphasizes the importance of the individual within the CPD process, as well as the close working relationship between all the stakeholders represented. The study makes practical recommendations that can be used to increase the effectiveness of CPD activity on both an individual and departmental level.

For Work in Progress contributions to this session see p. 90.

1545–1715
Scientific Session
CARS/*info*RAD™—Digital Imaging
Olympian Suite

1545
Invited Review
Digital radiography—too many numbers?
M Tatlow
Division of Professions Allied to Medicine, Room 212 Erlang House, Faculty of Health and Social Care, South Bank University, 103 Borough Road, London SE1 0AA, UK
Currently, there is an amazing amount of information and communication technology (ICT) impacting on the modern imaging or oncology department. Consequently, movements are being made to introduce these technologies into these work environments. These projects inherently involve a significant capital investment. History is littered with the debris of failed healthcare ICT projects. Such an example is the aborted HISS implementation in Winchester. Departmental managers rely significantly on many disparate advisors but they are required to maintain a wide and circumspect view of the process, often without a significant background in ICT. The pressure on the departmental manager is considerable. They rely on a certain amount of 'crisis management' in the extent of available reference material to achieve an acceptable outcome. This paper intends to examine if there are sufficient independent resources made available to the purchaser during the purchase process and whether the education sector can provide such independent material by the supplying of CPD courses, consultancy services or

the similar. The content will cover the areas of CR, DR, PACS and HISS. It is not intended to provide a panacea merely a catalyst. The discussion will review the extent of free resources as well as outlining potential education solutions for the prospective purchasers.

1615

First 43 × 43 cm flat panel silicon X-ray detector for digital chest imaging in clinical comparison with screen–film radiography

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PURPOSE: The diagnostic quality of a newly developed digital radiography system (DRS) was compared with a conventional film–screen system (class 400) in routine chest radiography. The diagnostic efficiency of this new technique in visualization of various anatomical regions was evaluated according to the German guidelines of technical quality requirements. MATERIALS AND METHODS: DRS is composed of a caesium iodide scintillator with a 43 × 43 cm (pixel size 160 μm) flat panel sensor based on amorphous silicon. In 100 patients posteroanterior (pa) and lateral images were acquired with both the digital and the conventional system. Three observers independently analysed the pa and lateral images with the ROC ranking method for 14 regions in the pa and 12 in the lateral view. The evaluation was repeated 2 weeks later in a different order and the images were rated a second time. RESULTS: Digital image quality was significantly superior to that of conventional chest films in the mediastinum, hilum, soft tissues and ribs; better than or equal in the retrocardiac, and retrosternal region. It was equally rated for the azygoesophageal recess, the thoracic spine and the intrapulmonary structures. CONCLUSION: The new silicon sensor technology has a high signal-to-noise ratio, fulfils the technical criteria of spatial resolution in chest imaging and is advantageous to the film–screen technique in contrast resolution owing to its high dynamic range. Visualization of anatomical structures was better than or at least equal to that of film screen images. DRS also offers diagnostic advantages through post-processing.

1625

Small field mammography: digital film–screen imaging

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Computed radiography using photostimulable phosphors has been in use for some time and is now an accepted imaging modality. An alternative form of digital imaging is direct digital imaging (DDI) which removes the need for handling and processing the phosphor plates. DDI systems are often based on charged couple device (CCD) technology which has some advantages over phosphor based imaging, such as improved spatial resolution. An inherent disadvantage associated with the use of CCD is the limited detector sizes currently available. One area in which CCD technology has made considerable impact is in small field digital mammography with field sizes up to 40 cm^2. These are used primarily for stereotactic localization procedures plus spot imaging and magnification views. Some manufacturers use large area CCD coupled directly to the imaging phosphor, others use a smaller CCD with a lens systems or fibre optic taper to required field size. KCARE (the King's Centre for the Assessment of Radiological Equipment) has recently evaluated a number of small field digital mammography devices, all based on CCD detectors, using subjective conventional mammography test phantoms. This study develops the evaluation further by objectively comparing the image quality and dose for the CCD devices and also for modern mammographic film–screen combinations. The parameters assessed include the modulation transfer function, dynamic range, noise equivalent quanta and image uniformity.

1635

The evaluation of four small field digital mammography systems

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Recent developments in diagnostic imaging technology have resulted in conventional film–screen image receptors being progressively replaced with digital devices. One area in which this new development has been successfully implemented is small field mammographic imaging. At the present time four manufacturers offer this facility as an option to their mammography X-ray systems. All the units are based on charged coupled device (CCD) technology and are designed to be used for stereotactic localizations, spot imaging and magnification techniques. As part of the Medical Devices Agency (MDA) evaluation programme, the King's Centre for the Assessment of Radiological Equipment (KCARE) has undertaken a comparative assessment of the four units. Prior to undertaking the evaluation, several test objects were identified which it was thought would provide relevant image quality data. In addition to this, a new test object was developed, based on a contrast/detail format. For each unit image quality was assessed by two independent observers. These observers were present at each of the four evaluations in order to provide a more consistent comparison between the units. An assessment of breast dose was also carried out. Initial findings suggest that when compared with film-screen technology, image quality is improved in terms of low contrast sensitivity although limiting resolution is poorer. Dose levels appear similar for both modes of imaging.

1645

Wavelet transform analysis and classification in digital mammography

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This paper presents an investigation on the performance of all the 360 real 4-tap wavelet filters when used for mammographic image analysis and classification. The images are analysed by using the following wavelet architectures: logarithmic splitting, wavelet packet, and adaptive splitting. The pattern recognition approach incorporates 20 statistical measurements, and five different classifiers. Overall, 272 digitized mammographic extracted subimages, 136 abnormal and 136 normal, obtained from the MIAS database were used in order to evaluate the performance of the wavelet transform analysis and classification. Our results suggest that: (1) The normalized variance values of the wavelet transform coefficients follow a specific pattern, which presents differences among the normal and the abnormal images. This finding can be used for the selection of the appropriate wavelet filter for mammographic image analysis; (2) The wavelet transform enhancement technique can be used as a potential discriminator for mass abnormalities; (3) The adaptive wavelet transform method for mammographic classification provides higher classification accuracy than the other wavelet based techniques.

1655

Assessment of wavelet compression for angiograms

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Telemedicine can be defined as the provision of healthcare through a combination of telecommunications and multimedia technologies with medical expertise. Image compression plays an important role in the archiving and transmission of medical images in telemedicine. There are many approaches to image compression. Lossy compression schemes have not been widely used for both clinical and legal reasons. However, standard and newer compression algorithms such as Joint Photographic Experts Group (JPEG) and wavelet-based compression can yield "virtual lossless" images with a compression ratio between 10:1 and 20:1, which produce statistically identical diagnostic results compared with using the original images without any lossy compression. In this paper, a wavelet compression algorithm has been applied to several kinds of popular medical images, such as angiogram of the coronary vessels, barium FT, ultrasound of the gall bladder, MR of the brain, CT scan, pulmonary angiogram, and X-ray of the hand. The images are still "virtual lossless" with compression ratio up to 50:1. The effects of the compression ratios on diagnosis for the angiogram of the coronary vessels have been assessed by a consultant cardiologist. The wavelet compression is a very efficient and powerful method for medical image compression. If this kind of compression is properly used and does not require much additional time for compression and decompression, it can significantly reduce the communications bandwidth, storage requirements and overall delay in telemedicine systems.

1705

Discussion

1615–1700
British Institute of Radiology
Silvanus Thompson Memorial Lecture
Hall 5

1615
Eponymous Lecture
Dose fractionation and normal tissue tolerance: in search of the holy grail

J W Hopewell
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For at least five decades clinical oncologists have attempted to formulate time, dose and fractionation factors that will enable safe normal tissue tolerance doses to be calculated. This requirement may be for logistic reasons, if a patient's treatment has to be changed, or alternatively it is required if a new modality is to be compared with an established existing treatment. It is an area of oncology that has attracted considerable controversy from the early days of the application of the nominal standard dose (NSD) concept of Ellis to the use of the linear quadratic (LQ) model. These approaches have always assumed equal biological effect per dose fraction, an assumption that has only recently been questioned even though, for example, it is well known that radiosensitivity varies with the position of a cell in the cell cycle. With the clinical use of multiple dose fractions per day, either using accelerated fractionation or hyperfractionation, repair of sublethal damage needs to be considered. Is it a simple mono-exponential process, as was initially assumed, or a more complete multifunctional process? This becomes even more important if existing models of dose fractionation are to be applied to high dose-rate pulsed brachytherapy. Can we achieve of the "holy grail of radiotherapy", are we approaching the end of the rainbow, or are mathematical models of dose fractionation in radiotherapy likely to remain a rough approximation to a very complex biological problem?

Notes

Tuesday 18 May

0830–1000
State of the Art Symposium
Management Issues
Hall 5

0830
Invited Review
Risk management related to clinical governance
A Yule
Clinical Governance, University Hospital of Wales, Cardiff CF4 4XW, UK
The purpose of this presentation is to highlight the way forward in risk management related to the introduction of clinical governance throughout a large National Health Service (NHS) Trust. The presentation will focus on a strategy for implementing clinical governance in the light of the Government's White Paper *The New NHS*. It will centre on the organization-required in the setting up of such a department to ensure that clinical standards are improved through openness and the sharing of information. This requires processes to be in place necessary to establish standards ensuring that risks are avoided, untoward events rapidly identified and fully investigated, lessons learned from the process and the results disseminated. A proactive approach has been taken by the University of Wales NHS Trust aimed at improving both patient care and the safety of staff. Experience has shown that for risk management to work there must be a culture of openness amongst staff and a willingness to learn from possible mistakes. It is crucial that all disciplines of staff are involved in the process and work together towards its achievement. Clinical governance involves the bringing together of services such as Clinical Risk, Clinical Audit, Complaints Management and Legal Services. For this to be successful it is important that appropriate management structures and clinical resourcing be made available and a culture developed which promotes learning, changes in practice and improvements to service. The presentation will outline the above issues and identify the progress made in the UHW Trust towards implementation of clinical governance.

0900
Invited Review
Strategic thinking in radiology
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The latest approach to business analysis is "strategic thinking". Thinking can be considered to be the initial step of "doing the right things", followed by planning — "doing things right". Strategic thinking in radiology (STR) is an approach for radiologists to learn how to "think" about business issues. It enables the user to "ask the right questions" in preparation for proceeding to find the right answers. It creates a "language" for dealing with a wide range of business issues. STR is an approach to providing the user with frameworks and processes for meeting the challenges created by rapid change. The focus is on effective communications and decision making by a diverse group of individuals. Establishing a common language is key to effective communications. This is a fundamental outgrowth of STR as a team proceeds to define and resolve problems and develop opportunities. A series of eight tools are presented along with case studies demonstrating their use and effectiveness. After the user gains some facility with the tools they will naturally modify these tools to better fit their specific situations. In addition, the users will find themselves creating new tools together with members of their teams.

0945
Discussion

0830–0945
Scientific Session
Hardware Developments in MR
Hall 6

0830
Invited Review
Hardware developments in MR: how and why do we need them?
I R Young
Robert Steiner MRI Unit, Imperial College School of Medicine, Hammersmith Hospital, Du Cane Road, London W12 0NN, UK
MRI systems comprise four components – three physically obvious (magnets, gradient coils and radiofrequency (RF) equipment) and the fourth hidden (software). In the early 1990s it seemed as though machine evolution was slowing, with a gradual but noticeable improvement in the then existing cylindrical magnet units using fields in the 0.5 T to 1.5 T range. Since then there has been a near explosion of diversity in magnet types. This release of energy has much further to go – interventional machines are still much too restrictive in terms of access, open machines are all low field and cylindrical magnets can work at much higher fields than is traditional. Machine cost is another key factor, as smaller, more affordable, machines will allow much more access to MR scanning for the population as a whole. Magnet diversity has far to go, and while gradient performance may well not develop too much more at the top end, the capability for enhanced gradient performance will extend to many more systems. RF development will be more subtle — but, possibly of even greater significance, software and computers will continue to evolve to exploit the capabilities of the hardware to the limit. The question based on the title, however, is "Do we need the new capabilities?". We are likely to get them regardless of how we answer this, and as no-one is in the least perturbed by the existence of a multiplicity of different types of X-ray equipment, why should a diversity of MR equipment cause concerns? There are clear gaps in what is available — primarily for diversifying patient access, and ensuring that MRI becomes the primary examination in every instance where it is capable of performing better than other modalities. The desirability of some other potential configurations is more controversial.

0900
Safety evaluation of high field MRI systems
D L Price, J P De Wilde, A M Papadaki, J S Curran and R I Kitney
MagNET, Department of Electrical Engineering, Imperial College STM, London SW7 2BT, UK
PURPOSE: The safety issues of acoustic noise and tissue heating resulting from radiofrequency (RF) power deposition become more important as the main magnetic field strength B_0 increases. Acoustic noise is a product of the Lorentz forces on the gradient coils which are proportional to B_0. Tissue heating is more significant on high field systems since RF power deposition is proportional to the square of B_0. MagNET, the MRI national evaluation centre, have investigated these issues on MRI scanners with 1.5 T and greater main field strengths. METHODS: Acoustic noise measurement methods were performed using a CEL-275 integrating sound level meter and CEL-192 omni-directional air condenser microphone. Tissue heating has been investigated with the use of a Luxtron Model 3100 fluoroptic thermometer. Both measurement systems are insensitive to the magnetic environment. Measurements were performed with volunteers and with phantoms. RESULTS: We present noise levels from a number of high field systems. The influence of various pulse sequence parameters is also shown. We have investigated the variation of noise level with position and the effect of having a volunteer in the bore. With regard to RF power deposition, we present estimated SAR values from phantom measurements and skin temperature measurements from volunteers. DISCUSSION: The results presented underline the increased safety concerns with higher field MRI systems. Acoustic noise levels in particular underline the importance of adequate hearing protection.

0910
Quality assurance for MRI: practical experience
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INTRODUCTION: In contrast to other common imaging modalities, there are few guidelines relating to the complexity and frequency of

TUESDAY

quality assurance (QA) assessments necessary for MRI. A comprehensive QA programme was therefore undertaken on a busy clinical MRI unit over the course of 1 year, in order to establish guidelines for QA needs in MRI. METHOD: Eurospin phantoms together with scanner manufacturer's (Siemens) phantoms were utilized. Spin echo images were acquired and, from these, QA parameters were measured. Signal to noise ratio (SNR) and image uniformity were measured daily using a quadrature send–receive head coil. Slice thickness, geometric distortion, slice position, image resolution and image ghosting were measured monthly using the same coil. SNR was also measured monthly on other coils in clinical use. RESULTS: All parameters were within expected limits, and were stable over the course of a year. Mean SNR was 82 (1.6 on the head coil) and there was no detectable drift of measurements. SNR did not vary significantly over the course of a working day. CONCLUSIONS: SNR is a sensitive although non-specific monitor of the status of the MR system. SNR can be measured by a radiographer without additional software in less than 15 min. For clinical scanners, weekly SNR checks are recommended, to obtain a quality standard against which any deviations can be seen. In-house checks are useful for comparison with manufacturer's service tests. For systems used for research or quantitative measurements, more comprehensive QA routines are desirable.

TUESDAY

0920

Application of neural networks to fMRI: increased sensitivity at low CNR compared with statistical methods

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PURPOSE: Current techniques for analysis of functional MRI (fMRI) time data rely heavily upon traditional statistical techniques. However, in recent years neural networks (NNs) have been utilized in similar areas of sequence recognition and detection. This study investigates two differing neural network architectures and, using synthesized fMRI data, compares them to a more traditional statistical method. METHODS: Synthesized fMRI experimental data were generated (within Excel, Microsoft) using a typical boxcar paradigm. 600 time-courses representing functional activation were simulated with varying Gaussian noise levels using the ratio of the activated values to the activation of the nominal "off-values", in effect the contrast-to-noise ratio (CNR). A further 600 time-courses representing an absence of activation were also simulated with varying Gaussian noise level combinations. To validate the performance of each NN another 1200 activated time-courses were generated along with a further 2400 non-activated time-courses. Each time-course was input to two differing NN architectures: probabilistic (PNN), and back-propagation (BPNN), and subjected to a Student's *t*-test to compare the difference between the mean values of nominally "on" and "off" time-points, as defined by the paradigm. Results: The *t*-test retained a high sensitivity, greater than 90%, until the CNR dropped to less than 1, where it fell substantially: 80% at 0.89, 77% at 0.8, 69% at 0.73, 58% at 0.67. Both NNs maintained sensitivities greater than 89% over the same range of CNR. CONCLUSIONS: This work demonstrates a technique for the analysis of fMRI data where results indicate that NNs are more sensitive than the *t*-test.

0930

Accuracy of volume estimation of small lesions with MRI

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PURPOSE: MRI estimation of summated lesion volume is used as an outcome measure in studies of pharmacological agents in multiple sclerosis (MS). This study explores the accuracy of volume measurements of small lesions using MRI. METHOD: A phantom consisting of small objects of known volume suspended in dilute $CuSO_4$ was scanned at a range of slice thicknesses. Measurements were used to assess a theoretical mathematical model of volume estimation against slice thickness. The model was then used to predict the effects of lesion size and image geometry on volume measurement accuracy. RESULTS: Variations in window level (threshold) and slice thickness (ST) introduced significant errors. Measurements closest to true area were produced at a threshold of 50%. Lowering threshold increased volume estimates up to 100%. Volume was also overestimated by a semi-automated local threshold technique. Accurate volume estimations were achieved when ST was 1/5 of object diameter. Error in volume estimation increased proportionately up to 100% as ST increased relative to object diameter. For lesions of typical MS size scanned at 5 mm ST in serial studies, a repositioning error of only 1 mm could lead to a 15% variation in volume estimation between studies. CONCLUSION: Accurate volume measurement of small lesions requires ST approaching 1/5 of anticipated lesion diameter. Lesion outlining techniques should be consistent between patients and within studies. Small MS lesions would be more accurately assessed with 3D techniques using 1 mm^3 voxels than the currently used 2D techniques. 3D techniques also remove the requirement for accurate patient repositioning.

0940

Discussion

0830–1030
Scientific Session
The Chest Vascular
Hall 8

0830

Invited Review

Current imaging techniques in pulmonary embolism

C J Herold
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Pulmonary embolism (PE) is frequently encountered in the hospital environment as well as in private practice. Accurate diagnosis of PE is of paramount importance not only because untreated PE is associated with a 25% increase in mortality rate because of recurrent massive thromboembolism, but also because of the potential complications associated with anticoagulation therapy. Imaging methods are important in the diagnostic work-up of patients with suspected PE, primarily because of the non-specificity of clinical findings and laboratory tests. The traditional imaging algorithm involves ventilation/perfusion (V/Q) scintigraphy and, when results are inconclusive, pulmonary angiography. However, increasing evidence from the literature and clinical experience show that this algorithm is far from perfect because V/Q scanning leaves the majority of patients without a definitive (conclusive) diagnosis. Furthermore, pulmonary angiography is an invasive procedure and clinicians are reluctant to use it in clinical practice. In addition, a survey from Great Britain shows that the technical equipment to perform both V/Q scintigraphy and pulmonary angiography is available in only one-third of all hospitals. With the introduction of spiral CT angiography (SCTA), a new technology is now available to address some of the disadvantages inherent in the above-mentioned techniques. SCTA provides fast, accurate, and non-invasive evaluation of patients with suspected PE. Because it is available in many healthcare settings, SCTA has already been incorporated into the diagnostic work-up of these patients. This review will focus primarily on SCTA technique, interpretation of findings, strengths and weaknesses, and discussion of the potential role for SCTA in various diagnostic algorithms.

0900

Severity stratification of pulmonary embolism by helical CT

J H Reid, J T Murchison and D H Hardwick
Department of Radiology, Borders General Hospital, Melrose TD6 9BS, UK

PURPOSE: To investigate the correlation between right ventricular size and pulmonary artery thrombus load demonstrable on helical CT in patients with pulmonary embolism (PE). To determine if this correlation can form the basis of a severity assessment of patients with thromboembolic disease. METHODS/MATERIALS: A prospective study of 94 consecutive patients investigated by helical CT for PE was performed. Thrombus load was calculated from the axial images using a modified Miller score (range 0–16). The maximum right ventricular minor axis dimensions (as expressed as a RV:LV ratio) were calculated from images obtained during the same CTPA. RESULTS: 36 patients had CT evidence of PE with Miller scores ranging from 1 to 16. Of this group, 12 patients had RV:LV ratios greater than 1.2:1. There was a strong correlation between rising Miller score and increasing RV:LV ration ($p<0.01$). DISCUSSION: Acute right ventricular failure is a principal cause of death in PE. Thrombolytic agents have been shown to reverse rapidly this phenomenon, but not without risk of haemorrhage.

Attempts have been made to produce a scoring system to aid selection of patients for thrombolysis. These systems have used thrombus burden assessment (Miller score using either CTPA or conventional angiography) or a direct assessment of RV dysfunction utilizing echocardiography. This study demonstrates that by using helical CT it is possible to combine RV assessment and direct quantification of embolic material. This has potential as a prognostic indicator which may guide thrombolytic therapy.

0910

CT pulmonary angiogram (CTPA): our experience in a regional cardiothoracic centre

A P Higginson, M Aslam and K Jepaplan
Department of Radiology, Glenfield Hospital, Leicester LE3 9QP, UK

PURPOSE: To determine the outcome of using CTPA in a select group of patients referred within a Regional Cardiothoracic Centre and to evaluate the usefulness of peripheral areas of hypovascularity identified on the lung window setting in diagnosis. The majority of referrals (76%) were from Respiratory Physicians as a primary investigation in patients with coexisting lung disease. METHOD: A retrospective review of 84 CTPA was performed over 20 months along with chest radiographs (CXRs) and available ventilation/perfusion (V/Q) scans. Scoring systems were used to reflect both the technical quality of the scans (1–3) and extent of thrombus detected in the pulmonary vessels (0 20). RESULTS: Pulmonary emboli were demonstrated in 17 (20%), (age range 19–85 years, 34 males) all of whom had abnormal CXRs. Peripheral hypovascular areas were identified in 11 patients with central thrombus and a further six patients without. In nine scans with scores >4 for extent of thrombus, there were associated peripheral areas of consolidation and infarction. 16% of patients had V/Q scans within 2 weeks of CTPA. Discordance between the examinations occurred in one case of extensive alveolar cell carcinoma. CONCLUSION: CTPA is most sensitive at detecting central thrombus. In the setting of an abnormal CXR with changes due to pulmonary embolism, the advantages of this modality are maximized. Peripheral hypovascular areas can be identified in association with pulmonary emboli and may be a marker of subsegmental emboli in cases where no central thrombus is demonstrated.

0920

Cardiac pathology demonstrated during CTPA

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PURPOSE: To assess the range and significance of cardiac pathology demonstrated in patients undergoing CTPA for investigation of pulmonary embolus (PE). METHODS/MATERIALS: Prospective study of 94 consecutive patients investigated for symptoms suggestive of PE. Chamber size, chamber morphology, ventricular wall thickness, ventricular wall enhancement, coronary artery calcification, valve calcification and pericardial fluid were assessed using modified mediastinal window settings. RESULTS: 27 patients had 35 cardiac findings. Of these, only eight patients had co-existing PE. Cardiac pathology ranged from left ventricular hypertrophy to significant pericardial effusion (>1 cm in diameter). Of patients with immediately significant cardiac pathology, two had overt LVF, one had an acute MI (confirmed by ECG and enzymes), three had significant pericardial effusions and two had apical left ventricular thrombus. DISCUSSION: A significant proportion of patients presenting with a variety of symptoms initially suspected as PE will subsequently be shown to have a cardiac aetiology. Ultrafast CT has been utilized to demonstrate acute cardiac disease, but this is not generally available. We have found that with the increasing use of helical CT for the investigation of PE a significant proportion of these cardiac pathologies can now be diagnosed. We present the range of our findings with illustrative examples.

0930

MR first pass imaging ^{201}Tl SPECT in acute myocardial infarction

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PURPOSE: To compare the prevalence and significance of regional hypoenhancement on first pass myocardial perfusion MR images with that of regional deficits in uptake of thallium-201 in patients with acute myocardial infarction. METHODS: 73 patients with proven acute myocardial infarction, treated with thrombolytic therapy, underwent both first pass perfusion MRI with gadobenate dimeglumine and thallium-201 SPECT between 2 and 6 days post-event. Both examinations were conducted at rest. The results of qualitative analysis by blinded reviewers were compared. RESULTS: 71/73 (97.3%) patients showed a deficit in thallium-201 uptake in the affected circulation. 34/73 (46.6%) patients showed deficits in thallium uptake in the non-affected circulation. First pass myocardial MRI is less sensitive than thallium-201 SPECT, finding concordant regional hypoenhancement in only 60/73 (82.2%) patients. However, in only 2/73 (2.7%) patients was there any abnormality reported in the non-affected circulation. There is a trend towards a normal first pass examination in patients with non-Q wave infarction and possibly in patients with inferior infarction. There is good interobserver agreement for regional hypoenhancement on the MR images (Cohen's kappa = 0.63 for anterior and 0.54 for inferior infarcts). The absence of hypoenhancement does not obviously reduce the risk of further cardiac events. CONCLUSIONS: First pass perfusion MRI with gadobenate dimeglumine compares satisfactorily with thallium-201 SPECT. Regional hypoenhancement is most commonly seen in anterior Q wave infarcts. The presence of normal first pass perfusion may not indicate a reduced risk of further cardiac events.

0940

Intravascular ultrasound in coronary artery disease: development of a decision analytic model

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PURPOSE: Decision analytic modelling may be used to compare options with differing outcomes and associated risks, for example as a vehicle for evaluation of diagnostic and therapeutic procedures. It is particularly useful when complete evidence on all outcomes is not available from controlled clinical trials. In this work, a generalized model was built representing the application of intravascular ultrasound (IVUS) in coronary artery disease, in order to investigate its effect on outcome and the economic implications of its use. METHODS: A multidisciplinary team of cardioradiologists, cardiologists, health economists and medical physicists agreed a decision tree with options on IVUS use: (i) not used; (ii) used only before a procedure; and (iii) used throughout a procedure. Subtrees were designed covering clinically feasible permutations of the interventions de-bulking, stenting and balloon angioplasty. The parameters of the model, probabilities, costs and outcomes were obtained from a systematic literature review. The results of published meta-analyses were employed for the branch where IVUS was not used. RESULTS: Three iterations were required to reach an agreed structure for the decision tree. The literature review revealed little data from controlled studies for many of the possible therapeutic pathways involving IVUS. CONCLUSION: Data on outcomes and diagnostic, therapeutic and economic impact are rarely available from single studies, but a decision analytic model allows good evidence on each to be drawn together from separate sources. The wide variety of applications of an imaging technique means that expert knowledge is essential from the problem formulation stage onwards.

0950

Coronary artery blood flow waveforms derived from biplane digital X-ray angiograms

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BACKGROUND: Measurement of coronary flow is an important tool in the assessment of coronary artery disease. We have validated a method to calculate absolute and mean blood flow waveforms from biplane coronary angiographic images. METHODS: Over a range of flow rates, biplane images were acquired during contrast injection of a moving, simulated coronary arterial segment incorporated into a pulsatile flow phantom. The phantom contained the tubular probe of an electromagnetic flowmeter (EMF). Subsequent ECG phase matched subtracted images were used, together with images of a calibration cube, to generate a parametric image where the pixel grey level represents iodine concentration as a function of time and distance along the true three-dimensional course of the vessel. Adjacent concentration-distance profiles were re-registered along the vessel axis to identify the true linear distance moved by a selected profile over a single frame interval (40 ms). Hence the instantaneous contrast bolus velocity is calculated which, with vessel cross-section, yields instantaneous flow. The technique was applied to a right coronary artery at 15 pharmacologically induced flow rates and compared with intracoronary Doppler velocity recordings.

RESULTS: For the phantom, multiple observations for all flow rates showed close agreement with EMF. For 15 observations in the coronary artery, mean ± SD flow measured by angiography and Doppler were 45.1 ± 19.8 and 42.5 ± 30.8 ml min^{-1} respectively. The regression equation, $y = 1.13x - 8.66$; $p < 0.01$, $r = 0.73$, where x = Doppler and y = angiography, shows good agreement between the two methods. CONCLUSION: This method allows the accurate determination of absolute blood flow values from angiographic images.

1000
Systematic literature review: electron beam CT and symptomatic coronary artery disease
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PURPOSE: A systematic review of the literature was undertaken to identify publications measuring the diagnostic performance of electron beam CT (EBCT) for angiographically significant coronary artery disease (CAD). METHODS: Electronic searches of Medline, BIDS ISI and other resources including the Cochrane Library, Embase and INSIDE, were performed. Bibliographic listings of retrieved articles were searched and manufacturers contacted. Study selection was a three-stage process with pre-defined inclusion and exclusion criteria; non-English language papers were excluded. A checklist approach was used to record risk of bias and methodological differences between studies. Quantitative synthesis of results was performed using summary receiver operating characteristic (ROC) curves, and the effect of methodological features examined by regression analysis. Papers investigating reproducibility were also sought. RESULTS: Of 28 relevant publications, 12 studies satisfied the inclusion criteria and were included in the review. Overall, for all age and sex groups, ranges reported were: sensitivity 93–100%; specificity 26–86% and negative predictive value 70–100%. Authors concluded that the most appropriate application of EBCT in CAD is to rule out obstructive CAD in the older population. Six papers were included in the quantitative synthesis, resulting in a sensitivity of 95% at the mean specificity 49%. None of the bias risks investigated showed a statistically significant relationship with diagnostic performance. Five studies of interexamination reproducibility gave differing results. CONCLUSION: For detection of CAD, EBCT has a low specificity compared with angiography. Most authors use a very low threshold to define the presence of disease; there is scope for further investigation of age- and sex-matched thresholds.

1010
The age–sex frequency of coronary artery calcification on 900 consecutive thoracic CT scans: a comparison of detection on conventional and spiral CT scanners
M P Callaway, M Rees and P R Goddard
Department of Clinical Radiology, Bristol Royal Infirmary
AIM: To identify the age–sex frequency on conventional CT scanning. To establish if detection is improved when a spiral CT acquisition is used. RESULTS: 900 thoracic CT scans were reviewed. 450 CT scans were performed using a conventional machine; 278 on male patients (age range 24–95 years), and 172 on females (age range 19–87 years). 450 spiral CT scans of the chest were reviewed; 270 on male patients (age range 24–91 years, and 180 on females (age range 23–88 years). In the under 40 age group there was no coronary artery calcification. No female patients in their forties had calcification present. One male patient was 95 years old when scanned and did not have calcified arteries. The scans were performed for a variety of clinical indications but most frequently for the diagnosis and assessment of bronchial carcinomas. Calcification of the coronary arteries was present in 26% of male scans and 15.6% of female scans when performed on conventional CT. Using spiral CT, 31% male patients and 25% females had calcification present. Overall, there was no statistically significant difference in the detection of calcification on thoracic CT scanning in either sex using either method. CONCLUSION: These results confirm that the presence of calcification increases with age and calcification is more prevalent in males than in females. The comparison of these two methods, whilst primarily performed for imaging of chest disease, also establishes the frequency with which coronary artery calcification is detected.

1020
Discussion

TUESDAY

0830–0930
State of the Art Symposium
Oncology Skill Mix
Hall 11A

0830
Invited Review
An empirical, theoretical and practice based perspective
[1]M Hammick and [2]E Glean
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Policy frameworks for commissioning cancer services in England and Wales, Scotland and Northern Ireland have all emphasized the value of multiprofessional teams in the delivery of improved patient outcomes. The effectiveness of such teams is highly dependent on the degree to which team members are able to retain their unique knowledge and skills and, where appropriate, share these. This combination, if effective, has the strongest potential to blur professional boundaries and successfully implement skill mix. This is the way towards integrated and seamless care but a way that is challenging, not in the least because it needs to be accepted by all the practitioners involved. Given the imperatives for teamwork in oncology, it is timely that a critical examination of the role of individual professions within the speciality is carried out. There is a need to clarify the meaning of what is to be a member of a given profession and to identify existing strengths and weaknesses for individual professions. This paper looks at current work on such an examination for radiographers. We explore policy issues within the various contexts that have been the driving force for skill mix in healthcare. Empirical work will be presented on the current profile and future development of the therapeutic radiography profession. In addition, we will outline work with other professions which aims to operationalize skill mix in clinical oncology. Finally, we will offer, for wider discussion, issues that remain unclear in this complex arena of change and suggest ways forward to address the most urgent of these.

0830–0930
Scientific Session
New Technologies Evaluation
Hall 11B

0830
The Medical Devices Agency Evaluation Service in the next Millennium
A Long and A Sant
Medical Devices Agency, Hannibal House, London SE1 6QT, UK
The Medical Devices Agency (MDA) continues to develop its Evaluation Service to help the future National Health Service (NHS) in its strategic management of medical devices for diagnostic imaging. The need for independent authoritative information to support purchasing decisions has never been higher. MDA evaluations provide rigorous assessments of devices in relation to technical and user performance and safety. This information is freely available to the NHS to help hospitals consider the suitability, performance, reliability and value for money of devices at the earliest stages of purchase, ensuring the best return on investment. Recent research into the needs of the NHS has led the Evaluation Service to refocus its resources to provide: (1) more user assessments from a wider range of clinical sites; (2) greater coverage of the market using brief evaluations and comparative reports; (3) more tailored advice in the form of training courses and consultancy; (4) greater accessibility to evaluation data via the Internet and NHSNet; (5) summary reports and product portfolios; (6) greater scope for customer input via the Internet, small advisory groups and response forms. In parallel, the Evaluation Service has responded to changes in the healthcare industry, including the introduction of CE marking and the purchase and installation of more complex equipment. The presentation will detail these developments and explain how the Evaluation Service is adapting to the needs of the NHS in the next Millennium.

0840
KCARE — the technical evaluation of X-ray equipment
C P Lawinski, D Smith and N S A Wells
KCARE, King's College Hospital, Dulwich, London SE22 8PT, UK
The King's Centre for the Assessment of Radiological Equipment (KCARE) is a Department of Health funded facility specializing in the evaluation of diagnostic X-ray equipment. The department has now been in existence for 20 years, during which time a wide variety of X-ray systems have been assessed. This paper summarises the results of the technical evaluations. Until 1997, equipment for evaluation was purchased from the X-ray companies, installed in KCARE and fully evaluated over a period of 1–3 months. The results of the evaluations were published as the familiar "blue cover" reports. More recently, evaluations have been performed at hospital sites or manufacturer's/supplier's premises to allow a wider range of equipment to be assessed. The current programme covers groups of specific types of imaging equipment. Product comparison reports are published in the journal *Diagnostic Imaging Review*, although stand alone reports are planned for the near future. These provide a clear comparison of similar systems and address issues relevant to selection and purchase. The technical evaluation involves a thorough investigation of electrical, mechanical and radiation safety of the system plus a full performance check and, where appropriate, an evaluation of image quality. An analysis of the earlier evaluations performed at KCARE showed, rather surprisingly, that less than half the systems tested were considered acceptable for use with little or no modification. More recent statistics suggest that the situation has improved considerably, with most systems being fit for their purpose, possibly as a result of the continuing evaluation programme.

0850
KCARE — the role of user assessment in equipment evaluation
N S A Wells, D Smith and C P Lawinski
KCARE, King's College Hospital, Dulwich, London SE22 8PT, UK
The King's Centre for the Assessment of Radiological Equipment (KCARE) undertakes the evaluation of diagnostic imaging and associated processing equipment. The aims of KCARE are to protect public health, safeguard the interests of patients and users and to ensure that equipment purchased offers value for money, in terms of complying with technical requirements and fitness for purpose. An evaluation consists of both a user/clinical assessment in a hospital environment and a full technical assessment of the equipment. Information is then available from the centre and is also published in evaluation reports. While equipment may be technically acceptable when measured against a standard, it can be unacceptable to users, not only in terms of its design, but also with regard to the images produced. User/clinical assessment is therefore important because it evaluates the equipment within the "normal" working environment and allows comparative information to be produced. The clinical evaluation of any unit involves the use of radiological/anatomical phantoms to assess image quality, an ergonomic assessment of the unit and discussion with operators on the use of the system. The clinical evaluators are also responsible for obtaining further information from users at other sites. Recently, KCARE has set up a Liaison Group in order to focus its evaluation strategy. The aim of this group is to review trends in purchasing and clinical workload and consider user issues which can then be addressed at future evaluations. The presentation will consider the benefits of user assessment and how they are undertaken.

0900
Imaging equipment and the Millennium Bug — how prepared are we?
G Dombrowe, R Davies and G Coppock
Siemens Medical Engineering, Bracknell, Berkshire RG12 8FZ, UK
The so-called "Millennium Bug" and its potential consequences for the continued operation of medical equipment after 31 December 1999 have been given a great deal of publicity, some factual, some ill informed and bordering on hysteria. In any case, the matter cannot be taken lightly and equipment manufacturers and users must work together in identifying the issues and implementing solutions. With only a few months to go before the deadline, the time has come to take stock and review industry's level of pre-preparedness achieved so far, as well as to outline any action that can and should still be taken. Since the beginning of 1998, the authors have been responsible for a comprehensive analysis of their company's equipment installed in the UK as well as for the resulting remedial action programme. They have also worked on industry-wide initiatives through the Association of X-ray Manufacturers (AXrEM). Practical problems and their solutions will be discussed, both from a technical and contractual viewpoint, as well as suggestions for effective exchange of information and cost containment.

0910
Institution-wide image distribution using the Internet/Intranet: a solution for image archive, primary interpretation, physician desk-top PC access
G W Boland, K Dreyer, D Sack, B J Wood and P R Mueller
Department of Abdominal Imaging and Interventional Radiology, Massachusetts General Hospital, Boston, MA 02114, USA
PURPOSE: An Internet/Intranet solution for image management has been installed in this hospital for 6 months. This paper examines the effectiveness of such a solution for archive, primary interpretations and PC desk-top availability to referring physicians with linkage to the hospital clinical information system. METHOD/MATERIALS: Using commercial software and the Web browser, all DICOM digital images (CT, MRI, US, nuclear medicine, CR, digital fluoroscopy) are available online. Short-term images are available in non-compressed form and long-term images in wavelet compressed form. Non-compressed images are automatically prefetched to diagnostic workstations. Wavelet compressed images are available on-line for up to 1 year. Online images are viewed in a Web browser with direct links to the hospital clinical information services. RESULTS: A total of 11 442 patients, 14 239 studies and 1 063 836 images are available online from the last 4 months. Image access through the Web browser on the hospital Ethernet is available in seconds, either at the diagnostic workstation for primary interpretion or over 1000 desk-top PCs in this institution. CONCLUSIONS: The Internet/Intranet provides an effective infrastructure for all aspects of image management and distribution. This not only reduces costs, but permits online availability to referring physicians either in their office, operating room or home with direct links to other hospital clinical information systems.

0920
Evaluation of PACS: results of relevance to staff who are planning to install a system
G C Weatherburn, S Bryan, J Watkins and M J Buxton
Brunel University, Health Economics Research Group, Uxbridge, Middlesex UB8 3PH, UK
There have been many claims about the advantages of installing a Picture Archiving and Communications Systems (PACS) in a hospital, but there is relatively little published evidence to support such claims. A multidisciplinary team of researchers at the Health Economics Research Group at Brunel University have completed, and published, an independent evaluation of the hospital-wide PACS at Hammersmith Hospital, London. The costs and benefits of PACS have been measured using a range of both quantitative and qualitative research methods including before and after comparisons, observational studies, questionnaires and interviews. Detailed studies have been undertaken within the radiology departments to identify changes due to PACS in reporting times, image and report turn round times, patient radiation doses, reject rates, preparation for clinicoradiological meetings and research projects. In addition, studies have been conducted to identify the impact of PACS on clinical practice in hospital departments which are high users of the radiology service including A&E, Respiratory Medicine, ITU and Orthopaedics. This presentation will outline the costs and benefits which have been identified, and aims at informing professionals who are planning to install a PACS, where the evidence suggests that they can and cannot expect to achieve savings in staff time and other costs, and where PACS has and has not been shown to improve the radiological service provided to the rest of the hospital.

0830–1030
History Symposium
History of Radiotherapy & Contrast Media
Olympian Suite

0830
Invited Review
The beginnings of radiotherapy
K E Halnan
Department of Clinical Oncology, Hammersmith Hospital, Du Cane Road, London W12 0NN, UK
This lecture covers the first 50 of the 100 years of radiology. Soon after their discovery X-rays and radium were both thought to be

valuable for treatment. The former was applied first to the skin, to benign and malignant conditions because of the limited penetration of the low energy rays available. The first biological effect of radium was also on the skin, discovered inadvertently by Becquerel. Radium needles and gynaecological applicators were constructed. Most of this early work was accomplished by dermatologists, surgeons and gynaecologists; the new specialty of radiology was not to begin until much later. By 1903 treatment was being given to all sorts of skin disease, including infections and lupus, as well as tumours. Radium was being used for cancers of tongue and lips, and tumours of the uterus. Its value was found to be improved when it was given at low intensity over 6 to 8 days. Dosage was measured by time of application and X-ray therapy by skin erythema and chemical "pastilles", all of them inexact. 250 kV X-rays began to be available after the Coolidge tubes arrived from the USA during World War I. By then it had been established that better effects could be obtained by using X-ray therapy spread in daily fractions over 3 or more weeks. By 1920 sufficient knowledge of both diagnosis and therapy had accumulated enabling Diploma examinations to be founded, the first being the DMRE (Diploma of Medical Radiology and Electrology) at Cambridge University. When radiologists did appear they practised both diagnosis and, as a poor relative, therapy. The roentgen unit was finally defined in 1928. During the short interwar period deeper tumours, and other diseases, began to be treated at higher energies. Finally, million voltage treatment arrived at St Bartholomew's Hospital just before World War II. The independent specialty of radiotherapy had been truly established, and was soon to have its own examination, the DMRT (Diploma in Medical Radiotherapy).

TUESDAY

0850
Invited Review
History of radium in medicine in Manchester
B W Fox
Paterson Institute Cancer Research, Christie Hospital, Manchester M20 9BX, UK
It was recognized in the first decade of this century that the newly discovered radioactive substance radium could possibly be used in the treatment of cancer, much like the Röntgen rays already being tried. In Manchester, Robert Biggs Wild was excited by this possibility, as his Röntgen machine was being particularly frustrating. He borrowed, then bought, some radium from Professor Arthur Schuster in the physics department to try on skin cancers in three patients and he noted some limited success. It was later, in 1914, that Sir William Milligan, a noted otolaryngologist and local politician and Sir Edward Holt, Bt, a local wealthy brewer, decided to pioneer the formation of a radium laboratory and clinic to make radium available for the treatment of cancer in the Manchester district. This element was far more expensive than gold. The money to purchase radium was obtained by the work of a few dedicated people who organized massive public support form local industrial towns throughout the northwest. From this considerable effort, achieved only days before the outbreak of World War I, the original Manchester and District Radium Institute and subsequently the Christie Hospital and Holt Radium Institute grew and developed. The fortuitous choice of Ralston Paterson as Director in 1931 and his wife Edith to pioneer research, enabled the combined hospital to become one of the leading centres of radiotherapy in the world, pioneering new technologies in the treatment of cancer. This is the story of radium over its 90 years in Manchester.

0910
Discussion

0920
History of contrast media
P Dawson
Abstract not received.

0940
Invited Review
The early development of radiographic contrast agents
A M K Thomas
Department of Diagnostic Imaging, Bromley Hospitals NHS Trust, Bromley BR2 9AJ, UK
In the 19th century there was rapid development in medicine. It was against this background that Wilhelm Conrad Röntgen, on 8 November 1895, discovered the new kind of radiation, which he called the X-rays. An early concern was the visualization of the renal tract. Using the cystoscope, ureteric catheters could be introduced to outline the ureters. It was a simple step to inject a radioopaque material (retrograde pyelography). A suspension of bismuth subnitrate was originally used and by 1906 the technique of retrograde pyelography was well developed. The initial agents were toxic and it was only by 1918 that the less toxic sodium and potassium iodide were introduced. In 1928, Moses Swick and Alexander Von Lichtenberg in Berlin produced the first successful intravenous urograms using the non-ionic Selectan neutral. Another compound, Uroselectan, produced excellent quality intravenous urograms with relatively little toxicity. Within 2 years of the introduction of Uroselectan in 1929, Binz and Rath developed Diodone and Uroselectan B. Schering Kahlbaum of Berlin supported Binz and Rath in developing these pyridine agents and they became the world's leading manufacturer of intravascular contrast agents. These compounds were successful and were the standard intravascular and urological contrast media for many years. This review will concentrate on the early history of the visualization of the renal tract.

1000
Discussion

1010
A hundred years of radiotherapy at The London Hospital 1886–1996
H F Hope-Stone
Department of Radiotherapy & Oncology, The Royal London Hospital, Whitechapel, London E1 1BB, UK
In 1896 radiation was first used at The London Hospital to treat rodent ulcers and breast cancers, and radium was used to treat epitheliomata. In 1922, Dr Gilbert Scott used wide-field irradiation to treat malignant and benign diseases. In the 1930s Mr Henry Souttar, a surgeon, used radium needles and radon seeds to treat carcinoma of the tongue, breast and rectum. In 1943 a new department of radiotherapy was established by Dr Frank Ellis. He was the first in the UK to use intraoperative radiation. Subsequently, in 1950, Dr Geoffrey Boden was appointed. His chief physicist, Dr Lloyd Kemp, showed that the international standard of measurement of the roentgen was too low. When Dr Geoffrey Boden died in 1957 he was replaced by Dr Walter Shanks. He and his chief physicist, Dr Montague Cohen, further developed the use of wedge-field techniques. Dr Shanks designed the first radon gun, which was used in the treatment of early bladder cancer. In 1975 he was succeeded by Dr Harold Hope-Stone. Manual insertion of radium for treatment of cervical and uterine carcinoma was replaced by an automatic afterloading machine, the Curietron. The chief physicist, Dr Stanley Klevenhagen, carried out innovative work with electron therapy. He also designed and built in the physics workshop a new 140 kV superficial therapy machine and a 50 kV contact therapy unit. In 1994, The Royal London and St Bartholomew's Hospitals were amalgamated and a joint radiotherapy department was established on two sites.

1020
All radiant within: radium as a poison
J M Guy
Radiology Department, West Suffolk Hospital, Bury St Edmunds IP33 2QZ, UK
From the first decade of this century it was apparent that the application of radium could have beneficial effects in certain diseases. Its approved medical uses came to be confined to surface treatment using plaques and needles, or teletherapy in a "bomb". However, radium could also be purchased in creams and tonics. Spa waters, at home and abroad, were advertised on the basis of the therapeutic properties of the radium they contained. The reported ill-effects of radium were most commonly the result of accidental ingestion or from preparation of radium by hospital staff, but internal doses of significant quantities of the substance were sometimes administered by unorthodox practitioners. Two cases of radium poisoning reported in the 1950s will be described.

0945–1115
Controversy Corner
Competence to Practise
Hall 11A

0945
Invited Review
Competence to practise — academic and clinical diagnostic managers' viewpoints
[1]D Adrian-Harris and [2]N Skivington
[1]*University of Portsmouth, Centre for Radiography Education, Winston Churchill Avenue, Portsmouth, Hants PO1 2UP, UK and* [2]*Royal Free NHS Trust, Pond Street, London NW3 2QG, UK*
This joint presentation will consider (from the perspective of each speaker) evidence arising from a collaborative multicentre study of issues and perceptions relating to competence. The research population was drawn from radiographers of all grades from more than 60 imaging departments and 10 radiotherapy departments.

1035
Invited Review
Therapy radiographers — newly qualified and fit for what?
[1]K Westbrook and [2]K Burgess
Departments of Radiotherapy, [1]*Bristol Oncology Centre, Horfield Road, Bristol BS2 8ED,* [2]*University of Liverpool, Liverpool, UK*
The radiotherapy service accepts that the quality of undergraduate training is set and monitored by the JVC on behalf of the CPSM and the profession, and achieves the minimum standards for State Registration. However, within the literature there are no data to define the level of competence the service expects newly qualified radiographers to have achieved, nor has research been carried out to determine the level of satisfaction from the service perspective. This presentation will discuss the issues involved in the competency of newly qualified therapy radiographers and reflect on why there may be variations in expectations around the country, which make consensus difficult. Particularly controversial is whether therapy radiographers should treat patients without a second, independent check of the set-up, as advocated in QART. This paper will also address the proposal of a pre-registration clinical year for therapy radiographers. Against a background of extensions in training for similar groups of health professionals, such as pharmacists, the opinions of therapy radiographers were sought. A postal questionnaire was sent to three groups, service managers, newly qualified radiographers and course leaders. Overall, the response suggested that the profession did not support the introduction of a pre-registration year, but could see the potential benefits and may have responded differently if a more structured model had been proposed.

1100
Discussion

1000–1200
Scientific Session
Head and Neck Imaging 1
Hall 6

1000
Invited Review
Imaging sensorineural deafness
J W Casselman
Department of Medical Imaging & MRI, A.Z. St-Jan Brugge, Ruddershove 10, Brugge B-8000, Belgium
Today, patients with sensorineural deafness are best examined using MR. CT is only used as the initial imaging technique when otosclerosis or a congenital inner ear malformation is suspected clinically. The membranous labyrinth (ML) is best examined using Gd-enhanced T_1 weighted images and thin (0.7 mm) gradient echo (GE) T_2 weighted images. The Gd-enhanced images are very sensitive; however, the GE T_2 weighted images are needed to add specificity and can, for instance, distinguish a schwannoma (intralabyrinthine fluid is replaced by the tumour) from acute labyrinthitis (intralabyrinthine fluid is normal) when an intralabyrinthine enhancement is seen. MR is also the most sensitive technique to detect rarer pathology. The same two sequences should be used to study the internal auditory canal (IAC). The majority of lesions in the IAC are schwannomas, and today high resolution MR can provide the surgeon with important pre-operative information that can alter the surgical approach. The nerve on which the schwannoma is situated can often be recognized on the thin T_2 weighted GE images, enabling the surgeon to choose the shortest approach. The same images can show if an intracanalicular schwannoma is touching the base of the cochlea (translabyrinthine approach can be used) of if fluid is still present between the schwannoma and the fundus of the IAC (hearing preservation is then possible and a posterior fossa approach should be used.) In cochlear implant candidates the GE images can be used to check if fluid is present in the ML and if the cochlear branch of the vestibulocochlear nerve is present. In the cerebellopontine angle additional T_2 weighted spin echo images can be used to characterize larger lesions and MR angiography images are suited to looking for neurovascular conflicts. However, in the latter case the patients more often present with tinnitus. Finally, a T_2 weighted spin echo study of the brain and brainstem should always be performed to exclude other pathology involving the auditory pathways (cochlear nuclei, trapezoid body, lateral lemniscus, inferior collicilus, medial geniculate body) and the auditory cortex. The most frequent pathologies involving the auditory pathways are: infarction, multiple sclerosis, tumours and trauma (concussions or haemorrhages).

1030
Imaging for cochlear implants: the importance of the latest techniques for pre-operative assessment
P D Phelps
Department of Radiology, The Royal National Throat, Nose & Ear Hospital, 330 Gray's Inn Road, London WC1X 8DA, UK
Accurate imaging to define the anatomy of the middle and inner ears became a necessity when the advantages gained from inserting electrodes within the cochleae of severely deaf patients were realized. Computed tomography in the axial plane will in most cases demonstrate a normal air-containing middle ear and a fluid-filled labyrinth of the inner ear. However, CT will not distinguish fluid from other soft tissue densities or demonstrate the nerves in the internal auditory meatus, although these can be assessed with MRI. Over 500 patients in this series have had implants and the following pathology was shown by imaging. Labyrinthitis obliterans of meningitic or otogenic origin resulted in sclerosis and varying degrees of obliteration of the cochlear lumen. Otospongiosis/otosclerosis affects the cochlear capsule and if severe may encroach upon the lumen of the cochlea. Transverse fracture of the petrous pyramid can result in severe or total hearing loss if bilateral. Congenital malformations of the inner ear may be associated with complete anacusis from birth or progressive loss and some may be at risk or a cerebrospinal fluid leak fistula. CONCLUSION: Computed tomography is the necessary imaging investigation before implantation as it provides a 'road-map' for the surgeon and will suggest deficiency of the cochlear nerve if the IAM is narrow. If auditory function can be confirmed clinically CT is probably enough. However, MRI is necessary to confirm the presence of a cochleovestibular nerve and is helpful to show fluid in the cochlear coils on T_2 weighted images.

1040
MRI in the investigation of sensorineural hearing loss: is contrast enhancement still necessary?
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PURPOSE: High resolution T_2 weighted imaging has been proposed as a more rapid and less expensive means of investigating patients with sensorineural deafness, particularly in the exclusion of acoustic neuromas. Whether the accepted "gold standard" of contrast enhanced T_1 weighted images can be omitted, however, remains controversial. MATERIALS/METHODS: Over a 14 month period we prospectively compared the use of axial 3 mm 2D turbo spin echo T_2 weighted MRI with contrast enhanced T_1 weighted spin echo sequences in the evaluation of 340 patients presenting with audiovestibular symptoms. The T_2 weighted image findings were documented by the reporting radiologist prior to seeing the contrast enhanced images and a decision made as to whether contrast enhanced images would have been needed to issue a normal or abnormal report with complete confidence. RESULTS: 25 patients (26 lesions) had IAM/CP angle masses identified by contrast enhanced T_1 weighted images, all of which were seen on the T_2 weighted TSE sequence (21 acoustic neuromas, 3 meningiomas, 2 metastases); there was only one false positive and one false negative case. Six patients had labyrinthine enhancement on T_1 weighted imaging; all six were considered normal initially on the T_2 weighted images although three were subtly abnormal in retrospect.

Overall, the T_2 weighted sequence was judged to be neither conclusively normal nor abnormal in 52 patients (15%) who would have required contrast injection before a definitive report could be issued. CONCLUSION: We conclude that the ideal non-contrast "screening test" requires a greater degree of spatial resolution than that afforded by the 3 mm 2D T_2 weighted TSE sequence. Our initial experience suggests 3D T_2 weighted TSE sequences have considerable potential.

1050

Imaging of bone destruction in squamous cell carcinoma of the mandible

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PURPOSE: To assess the accuracy of pre-operative imaging in assessing the presence of bone destruction in squamous cell carcinoma of the mandible. METHODS: All cases of squamous cell carcinoma of the oropharynx adjacent to the mandible referred to the Regional Maxillo-Facial Unit between 1991 and 1997 were considered. Our imaging protocol for the assessment of such lesions and the potential for bone invasion includes an orthopantomogram (OPG), an isotope bone scan and an MR scan (coronal STIR, axial STIR, and axial T_1 pre- and post-gadolinium). The examinations for each case were evaluated as positive or negative for bone invasion of the mandible. The features indicating bone destruction in our experience are discussed. In some cases the imaging strategy fell outside our protocol and the reasons for this are presented. RESULTS: The isotope scan in isolation proved a sensitive but non-specific tool. MR was both sensitive and specific in assessing bone destruction. Signal changes on the MR STIR sequence proved the most reliable indicator of bone invasion. We present the correlation of extent of bone destruction, as demonstrated on MR with accurate pathological analysis of the resected bony specimens. CONCLUSION: MR was the most reliable imaging modality in assessing the presence and extent of bone destruction of the mandible correctly.

TUESDAY

1100

Non-contrast MRI for assessment of lymph node involvement in oral cavity tumours

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Accurate nodal staging is essential in assessing prognosis and planning neck dissection for oral cavity tumours. MRI is the most convenient technique, being the modality of choice for staging the primary tumour. The objective is to assess non-contrast MRI for lymph node involvement. 25 necks (9 unilateral and 7 bilateral) in patients with oral cavity tumours undergoing MRI, surgery with neck dissection and histology were included. MRI (Siemens Impact 1.0 T, neck coil) includes T_1 and T_2 (mainly STIR fat suppressed) weighted scans. Scans were reported in consensus by two radiologists blinded to the histology findings. Results show 100% specificity for malignancy in the presence of central inhomogeneity, ill defined margins or extracapsular spread. The sensitivity however is low (57%). Long axis nodal size of >1 cm has extremely poor predictive value and 1 cm can be considered a normal lymph node size in this group. Using >1.5 cm as a criterion, along with lymph node pattern, provided acceptable sensitivity and specificity (93% and 72%). Specificity is improved if symmetrical nodal enlargement at all levels with normal architecture are interpreted as reactive (sensitivity 93%, specificity 82%). Using short axis measurements did not improve accuracy. MRI is satisfactory for staging the neck for prognosis and planning neck dissection or radiotherapy. However non-enlarged nodes with microscopic involvement are missed and therefore precluding surgery on the basis of MRI imaging is not possible. Hopefully, specific contrast media will aid this area.

1110

Investigation of the parotid—where are we?

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PURPOSE: To review parotid imaging and to correlate the imaging findings with subsequent histological diagnosis. METHODS: A review of 56 consecutive parotidectomies referred by six different trusts within the region, over a 12 month period, was performed. Correlation was made between the imaging findings and subsequent histology. Investigations included 25 CT, 15 MR, nine ultrasound (US), six sialograms and two radioisotope scans. RESULTS: CT proved the most reliable imaging tool in correctly diagnosing a parotid mass and and differentiating benign from malignant lesions. MR was also reliable. In only one case MR erroneously diagnosed a case of focal sialadenitis with fibrosis as a benign superficial lobe tumour. There was a good correlation between the ultrasound reports and histology in the nine cases, where it was done. Sialography was unreliable in diagnosing both small tumours (two cases) and sialadenitis with fibrosis, proven histologically. Three of these four cases were reported as normal on sialography. The two radioisotope scans showed abnormal tracer uptake in chronic sialadenitis and sialolithiasis, confirmed histologically. CONCLUSION: This multicentre study shows that various imaging tools are used for the investigation of the parotid. In this assessment MR, CT and US provided accurate information regarding the presence and site of a parotid mass and gave good correlation between differentiation of benign from malignant histologies. This would suggest that whichever imaging modality is chosen, radiologists have adapted to that particular tool for the assessment of parotid mass lesions.

1120

Prevalence of dental disease as a cause of maxillary sinusitis on screening sinus CT

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Departments of [1]Diagnostic Imaging and [2]ENT, City Hospital, Birmingham B18 7QH, UK

PURPOSE: CT scanning is used to evaluate both the extent and the potential aetiology of inflammatory sinus disease. The close anatomical relationship of the root apices to the maxillary sinuses makes dental disease a potential causative factor for maxillary sinusitis. We aimed to establish whether there was an increase in the prevalence of maxillary sinus disease in patients with restorative dentistry as demonstrated by screening sinus CT (SSCT). METHOD: 330 SSCTs were retrospectively reviewed for the presence of focal maxillary floor disease and non-focal maxillary sinus disease, which was then related to the presence of restorative dentistry. SSCTs were also analysed for the presence of osteomeatal complex approximation and sinus disease elsewhere, which would make it less likely that dental disease was the main aetiological factor for maxillary sinus disease. RESULTS: There was a statistical relationship between the presence of restorative dentistry and focal maxillary sinus floor disease, both with or without the presence of other sinus disease. The presence of restorative dentistry did not, however, influence the overall prevalence of maxillary sinus disease. CONCLUSION: The presence of restorative dentistry should be recorded as a potential source of focal maxillary sinus disease when reporting SSCT's. In such instances, it may be more appropriate for the patient to undergo dental assessment.

1130

Quantification of the effects of the oral decongestant pseudoephedrine by MRI and posterior rhinomanometry

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PURPOSE: Currently, the efficacy of a nasal decongestant is primarily assessed by measurement of nasal airway resistance (NAR) via rhinomanometry. However, rhinomanometry cannot assess specific areas of the nasal cavity. This study was designed to evaluate MRI as a technique to detect changes in nasal patency and sinus pathology in the common cold following treatment with an oral decongestant. MATERIALS & METHODS: 51 volunteers suffering from a common cold underwent posterior rhinomanometry and MRI both prior to and 3 h after administration of either a 60 mg or 120 mg dose of oral pseudoephedrine or a placebo. NAR was measured using an NR6-2.2 rhinomanometer, and MRI was performed using a 1.5 T GE Signa scanner. Images of the paranasal sinuses from the tip of the nose to the posterior wall of the sphenoid sinus were acquired using a T_2 weighted fast spin echo (FSE) sequence. Total mucosal volumes were determined for the maxillary sinuses, inferior, middle and superior turbinates, nasal septum, frontal sinus and sphenoid sinus using a seeding threshold technique. RESULTS: Treatment allocation was randomized and 16 patients received placebo, 17 received single dose and 18 received double dose. Paired t-tests revealed significant differences between pre- and post-treatment values of septum, inferior and middle turbinate volumes in patients receiving the drug. Analysis of covariance revealed greatest reduction with double dose compared with single dose for values of NAR and inferior and middle turbinate volumes. CONCLUSIONS: MRI can be used to assess regional changes in mucosal volume and the efficacy of cold treatment.

1140
CT of orbital dermoids: a 20 year review
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INTRODUCTION: We review the CT features of orbital dermoids presenting to our institution over a 20 year period, representing the largest review in the current literature. METHODS: CT studies from 1977 to 1997 were reviewed by one of the authors (SJC). RESULTS: There was a total of 159 patients, all having unilateral single dermoid cysts; 81 on the right and 78 on the left. 86 were in male and 73 in female patients. The mean age at imaging was 29 years in males and 27 years in females. The lateral aspect of the orbit was the commonest site (69%). 135 (85%) dermoids had adjacent bone changes. 77% of dermoids had a visible wall. Heterogeneous CT attenuation within the cyst resulted in wall irregularity and was seen in 13% of patients. Dermoids can rupture causing an inflammatory type response and resultant soft tissue outside the cyst and occurred in 20% of our patients. Only 14% of dermoids had calcification and 4% had fluid levels. Nearly half had a CT attenuation of either fat, less than fat or more than fat and less than vitreous (water density). 47 (30%) had a density solely that of vitreous or more than vitreous. CONCLUSION: Orbital dermoids are frequently extraconal and located at the lateral canthus. They commonly have a well defined wall, no abnormal soft tissue outside the cyst and areas of low density within them. Calcification, fluid levels and inhomogeneity are uncommon. We will illustrate the various imaging features discussed.

1150
Meningiomas involving the petrous temporal bone
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Meningiomas arise from arachnoidal cells and about a third come from meninges associated with the skull base. Thus meningiomas may arise from any meninges lined surface of the temporal bone, but meningocytes may be found along cranial nerves and jugular fossa or below. Meningioma is the second commonest tumour in the cerebellopontine angle after acoustic neuroma. Meningioma involving other parts of the temporal bone are very rare and consequently the correct diagnosis may be difficult as these tumours are slow growing and may be large when they present. Clinically, a vascular retrotympanic mass may be indistinguishable from glomus tumour. Six cases of meningioma affecting the under surface of the temporal bone are described in this account. The presenting symptoms were bizarre and initial diagnosis difficult. In three patients, there was a mass in the infratemporal fossa, but with diffuse soft tissue calcification. Compression of the brainstem in the region of the foramen magnum occurred in four patients. However, the combination of ragged calcification and hyperostosis shown by CT combined with intense contrast enhancement and "dural tail sign" shown by MRI are characteristic, as well as the broad-based attachment to the surface of the petrous bone. The hyperostosis should not be mistaken for fibrous dysplasia.

1000–1100
Scientific Session
Imaging in Radiotherapy
Hall 11B

1000
Invited Review
Use of MRI in Radiotherapy Treatment Planning
H J Appleby
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MRI can be a valuable tool for the localization of tumour volumes for radiotherapy owing to its superior soft tissue contrast compared with CT. For example, several studies have concluded that on MR images the apex of the prostate can be localized more accurately than with CT. Other studies have demonstrated advantages of MRI for localizing cranial tumours. The ability to obtain high resolution images in sagittal and coronal planes, and to image the patient with the Open MRI scanner in treatment positions which cannot easily be accommodated on a CT scanner are examples of further advantages of MRI over other localization methods. A number of issues have to be addressed in incorporating MRI into the treatment planning process, for example, correction of MR images for distortion, registration of images with CT, integration of MR images into the treatment planning system, scanner quality control checks and methods of treatment verification. This presentation will describe the approaches to the above issues that have been explored and implemented in the course of commissioning a Siemens Open MR scanner for radiotherapy planning.

1030
SPECT/CT image registration using a stereotactic radiosurgery planning system
W S Jaafar, R Hugtenburg, P Julvan, A H Beddoe, J McMullen and G Cruickshank
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PURPOSE: The BrainLAB BrainSCAN sterotactic radiosurgery system has recently been installed at the Queen Elizabeth Hospital, Birmingham. Integral to the system is an MRI/CT image fusion package. While the package is designed for MRI images where internal anatomical markers are used in the fusion process, for SPECT images external fiducials must be used. This presentation examines the accuracy and clinical efficacy of employing the BrianLAB system for SPECT/CT image fusion using multimodality fiducial markers manufactured by Intermark Medical Innovations Ltd (Baltimore, USA). MATERIALS/METHODS: Up to eight external fiducials were applied to a humanoid head phantom (RANDO) imaged using a standard GE9800 CT sequence and, after injecting $^{99}Tc^{m}$ into markers, again imaged with an ADAC VERTEX EPIC dual headed gamma camera. Independent numerical simulations for rigid body transformations were compared with BrainSCAN calculations. RESULTS: In both approaches the optimum registration was achieved by minimizing the sum of rms distances between corresponding points in the two images. After appropriate scaling both methods achieved mean rms errors of between 1.8 and 2.5 mm with a slight improvement as one increased the number of fiducials from three to eight. CONCLUSIONS: It is considered that any given point in a clinical image can be determined with an accuracy of the order of ± 5 mm (95% confidence) provided one uses three or four external fiducial markers as widely spaced as possible. Application of the technique to patients achieves satisfactory images and the clinical utility of multimodality markers for SRS patients is currently being evaluated.

1040
Comparison of voxel similarity measures for automatic image registration using treatment planning CT images
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PURPOSE: Image registration techniques using voxel intensity similarity measures (VSMs) promise high accuracy and can be fully automated. In this study, four VSMs were compared near the optimum image registration transform. From the results patient movement was estimated in immobilization shells used in radiotherapy treatment. MATERIALS AND METHODS: Five sets of 3D CT head and neck images were obtained before and after injecting a contrast fluid. Patients were in the treatment position and immobilized with a mask. The time interval between the two image acquisitions was less than 15 min. Three 256 × 256 slice pairs with 36 mm spacing were taken for each patient. Four VSMs were compared: sum-of-square difference (Σ^2), correlation coefficient (r), mutual information (H_m) and entropy (H_e). VSM function values were calculated near the optimum rigid image registration transform for full and subsampled images. For every VSM, the registration transform was estimated from contour plots. RESULTS: The VSMs Σ^2/r and H_m/H_e had their optimum at slightly different registration transforms. Position differences up to 0.4 mm were found. The average patient movement in the shell was 0.75 mm (0.38 mm SD) and 0.17° (0.10° SD). CONCLUSION: In a relatively ideal situation small differences in optimal registration transforms were found. In clinical practice these differences will increase owing to local optima and flat curves near the optimum. Patient movement in the immobilization shell during a radiotherapy treatment session exceeds a millimetre.

1050
Registering electronic portal images to CT: feasibility study for verification of radiotherapy in the thorax
H V James, D J Mott, P A Burt and R Stout
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Electronic portal images (EPIs) of lung tumours proximal to or infiltrating the mediastinum often cannot be interpreted adequately in order to allow informed decisions about field placement errors to be made. A retrospective patient study was undertaken to assess a method relating anatomical landmarks in EPIs to fixed points

identified in CT scans from which treatments were planned. Software on our treatment planning system was adapted to enable points from planning CT scans to be projected onto scaled EPIs. The bifurcation of the trachea is a relatively fixed structure visible in the majority of central thorax EPIs. Markers placed on CT slices at the centres of trachea and main bronchi were overlaid on EPIs obtained during treatment. The translation required to align the markers with the bifurcation of the trachea as seen in an EPI represented the field placement error. A study of 18 patients undergoing radiotherapy for central lung tumours was carried out to assess the clinical usefulness of this method. In the majority of EPIs analysed, addition of anatomical markers from planning CT scans aided identification of the bifurcation of the trachea. Field placement was quantified in 65 out of 79 images and field placement errors were classed as significant (> 1 cm) in six cases. This study has shown that relating anatomical structures in EPIs to fixed points easily identifiable in planning CT scans improves interpretation of images of central lung tumours. This method is now being incorporated into routine clinical use. Studies assessing patient movement during treatment and set-up variations will be undertaken.

1015–1100
British Institute of Radiology
Presidential Address
Hall 5

TUESDAY

1015
Interventional radiology in cancer
A Adam
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Many patients require long-term venous access for the administration of chemotherapy. The placement of tunnelled central venous catheters under fluoroscopic guidance is a significant improvement over traditional surgical methods, minimizing risk and increasing patient convenience. Metallic endoprostheses can relieve malignant obstruction in many organs. Compression of the superior or inferior vena cava can be treated effectively with such devices. Obstructive jaundice can be relieved at a lower cost and with fewer risks than those associated with the use of percutaneous plastic stents. Metallic stents are employed in patients with colonic obstruction, either for palliation or in order to improve the patient's condition prior to a definitive operation. In patients with malignant obstruction of the gastric outlet and duodenum, metallic endoprostheses are replacing surgery. Percutaneous methods of ablation are proving an effective alternative to surgical resection in patients with hepatic malignancy, especially when the extent or location of the tumours precludes a surgical operation. Injection of ethanol is effective in the treatment of vascular tumours, such as hepatocellular carcinoma and endocrine liver metastases, but is ineffective in relatively avascular tumours such as colorectal metastatic disease. Thermal methods of ablation are being increasingly employed in the management of liver metastases, under ultrasound, CT or MR guidance. Radiofrequency and laser techniques can coagulate liver tumours effectively. Careful selection of patients is important to minimize the number of recurrences. Improved imaging guidance methods and refined instruments and techniques will further extend the role of interventional radiology in the management of patients with cancer.

1045–1215
State of the Art Symposium
MR of the Chest
Hall 8

1045
Invited Review
Magnetic resonance pulmonary angiography
A R Moody
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Magnetic resonance pulmonary angiography might be called upon in a number of different clinical settings: conditions which cause intraluminal obstruction of the pulmonary arterial system (thromboembolic disease); conditions which extrinsically invade the vessels (lung tumours); and congenital conditions of the blood vessels themselves which need further definition (arteriovenous malformation). In addition to investigation of the pulmonary vasculature similar MRI techniques will be applicable to the investigation of other vascular structures within the chest (thoracic aorta and systemic veins). With the realization of MRI's ability to demonstrate flowing blood, the pulmonary vasculature has always been a target for non-invasive MRI. However, imaging in this setting is fraught with difficulties. Physiological movement from pulsating vessels and the heart, along with respiratory movement all act to degrade angiographic images. Early attempts at pulmonary angiography employed either breath-held 2D or free breathing 3D techniques. While achieving some limited success, resolution within the smaller vessels was limited. With the revolution within the vascular tree upon the development of rapidly acquired 3D contrast enhanced techniques, MR pulmonary angiography became, for the first time, a viable clinical tool for the investigation of pulmonary emboli (PE). The technique is easy to perform and requires the patient to suspend respiration for approximately 15–20 s, although this figure is decreasing as further technical improvements are introduced. While the maximum intensity projection images are attractive, only large emboli will be detected using this post-processing. Viewing the raw data is often more fruitful. The most important technical aspect is the delivery of the contrast medium. This, however, may become less of a problem with the development of blood pool contrast agents. Some groups have attempted to use these contrast enhanced techniques to visualize lung perfusion. This then, in combination with a ventilation imaging technique using oxygen or hyperpolarized helium, can be used to perform ventilation/perfusion studies — which in the setting of PE seems a particularly retrograde step! Another means of making the diagnosis of PE is to visualize the embolus directly. One of the first reports of PE imaging used a standard T_1 spin echo technique to do just that, and further reports using spin echo have had some success. More recently, breath-hold rapid gradient echo techniques have allowed accurate visualization of PE. Patients with pulmonary AVM will normally undergo conventional pulmonary angiography as therapeutic embolization of these lesions can be carried out. However, road-mapping the abnormality prior to the interventional procedure may be helpful. Similarly, investigation of patients with a possible abnormality, or patients being screened or followed because of a family history, can be carried out, thus avoiding invasive conventional angiography.

1110
Invited Review
MR ventilation perfusion scanning and the use of hyperpolarized gases
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Magnetic resonance has developed as a versatile and sensitive method of imaging the body, but until recently application in the lung has been limited by motion of the lung and heart, and by signal dephasing in lung parenchyma caused by susceptibility arising from the proximity of air/water interfaces. This has limited application largely to the mediastinum, hilum, pleura and chest wall. Technical developments have led to improved visulization of pulmonary arteries using MR angiographic techniques, and developments in imaging techniques, particularly projection reconstruction, are offering the possibility of much improved parenchymal imaging. A major innovation, which complements these advances, is the development of hyperpolarized gas imaging. With proton MRI, only some six nuclei per million are polarized, yielding a very weak signal only compensated in most tissues by the high abundance of hydrogen atoms. Although techniques for producing much higher polarization have been known in physics research for a considerable time, they have only recently been applied in MRI to the noble gas isotopes ^{3}He and ^{129}Xe. Both of these gases have favourable NMR properties, and by directly or indirectly transferring energy from tuned circularly polarized lasers, polarizations of up to 60% can be obtained, some 5 orders of magnitude greater than the normal equilibrium signal. For measurements in the lung, the gas can be delivered either by inhalation or by intravenous administration. Polarization approaches, delivery methods and applications *in vivo* will be discussed and compared with conventional approaches. Based on our experience, recent developments in vascular delivery technology will be described.

1135
Invited Review
MRI of pulmonary malignancy
[1]P R Goddard, [1]M M Calloway and [2]M Hetzel
[1]*Directorate of Radiology and* [2]*Department of Respiratory Medicine, Bristol Royal Infirmary, Bristol BS2 8HW, UK*
Developments in MR technology now permit very rapid scanning, breath-hold techniques, MR angiographic studies and interventional work that was not possible with MRI just a few years ago. MRI has been used successfully in the detection and staging of pulmonary malignancy of all kinds. It has been shown to be more accurate in predicting outcome than CT or surgical staging of carcinoma of the bronchus and is accepted by most centres as the technique of choice when the carcinoma involves the apices, diaphragm or chest wall. It is of considerable value in assessing the mediastinum, where cine MR can also prove useful, and has a developing role in the lungs. The continuing development of machine design has led to various configurations of open systems. In Bristol, one of our machines is a Siemens 0.2 T open MRI. This has been used in association with a unique prototype MR compatible bronchoscope for the assessment and therapy of pulmonary malignancy and this will also be discussed.

1200
Discussion

1100–1230
Scientific Session
Audit & Management
Olympian Suite

1100
Plain film hot reporting—a survey of current practice in the UK
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PURPOSE: To assess the extent of plain film hot reporting in radiology departments in the United Kingdom. MATERIALS AND METHODS: Questionnaires were sent to radiology departments throughout the UK to establish how many offer this service and which type of films are reported in this way. Respondents were asked additional questions, including which types of films they believed should be hot reported in ideal practice, the reasons which prevented them from achieving their ideal practice and whether there were trainee radiologists in the department. RESULTS: A 93% response rate was achieved from the 295 questionnaires circulated. In total, 92 of the 263 (35%) general radiology departments which responded offered a hot reporting service. However, there was a wide regional variation in the proportion of departments offering hot reporting. In-patient films were the type most commonly hot reported. The main discrepancy between current and ideal practice was in A&E hot reporting which was given a higher priority in ideal practice than is achieved in current practice. Hot reporting was more often available in departments with trainee radiologists than in those without (45% and 26%, respectively). CONCLUSIONS: A very high response rate indicates considerable interest in the organization of hot reporting in radiology departments. Only one-third of departments presently offer this service and there is a wide regional variation. The types of film hot reported generally match radiologists' ideal practice but A&E reporting is given a much lower priority in current than in ideal practice.

1110
Error in CT reporting: does clinical information affect reports?
A Leslie, A Jones, D Fox and P Goddard
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A study was performed to determine whether clinical information on request cards had an affect on the final report from CT of the body. 100 patients undergoing CT of chest, abdomen and pelvis were studied. A report was initially written without access to the clinical information. The request card was then read and the findings and interpretation following access to the clinical information were recorded. A record was made of discrepancies between the reports before and after clinical information. The alteration in the report was classified as minor (not clinically significant and unlikely to alter management) or major (likely to alter management) and related or unrelated to the main diagnosis. A record was also taken if the clinical information was considered to be misleading. A second observer undertook the same exercise. Reports were agreed by consensus. Discrepancies between the two reports were noted. The clinical information was found to be most important when investigating patients who had undergone previous treatment. Knowledge of previous surgery or radiotherapy was particularly useful and major errors of interpretation were common in this group of patients if the clinical information was not available. Without information, CT of abdomen and pelvis was more difficult to interpret than chest CT. False positive and false negative errors and misinterpretation of abnormalities would, however, have been made in a third of the patients involving all areas of the body if the clinical information had not been available. The most common inaccuracy in clinical information was directing attention to the wrong side of the body.

1120
The effects of vetting requests for in-patient CT
R L Harrison, B Housden and A K Dixon
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PURPOSE: To assess the process and outcome of hospital in-patients for whom body CT was requested but not performed. MATERIALS AND METHODS: For 6 months, reasons why CT was not performed were recorded, together with relevant discussions with clinicians. Subsequent referrals for alternative investigations were noted. The eventual outcome of the patients was monitored via the patients' records. RESULTS: 75 patients (7.5% of 1001 inpatient requests) were identified where body CT was not performed after an electronically generated request. In 52/75 patients the Radiology Department did not accept the CT request during the vetting process. Criteria used for rejection included referrals outside national guidelines (16), better alternative investigations (8), time constraints (15), over-zealous requests (4) and clinicians' erroneous interpretation of preceding imaging investigations (9). 14 CTs were cancelled by a clinician; a further nine were not performed for miscellaneous non-medical reasons. In no case could the death of a patient be ascribed to CT not being performed. CONCLUSION: Most (98.5%) CT requests comply with current guidelines, disproving a perception that many radiological referrals are inappropriate. Radiologists have to turn down some appropriate CT referrals due to a lack of CT capacity. Although no patient died as a result of not having CT, lack of CT contributed to delay in diagnosis.

1130
MRI and CT scanning services: a pan-European perspective of patient experience
A C Eggleton, T Grajewski and S Moss
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A study funded by the European Commission was undertaken to investigate the efficient use of scanning services. 15 sites in four European countries were studied: the United Kingdom, Ireland, Spain and Sweden. A number of qualitative and quantitative factors were investigated ranging from running costs to user satisfaction, using questionnaires, interviews and observational instruments. Response rates for patient questionnaires were good across all countries with excellent responses in the UK sites, ranging from 70% to 92%. The results in this paper primarily reflect patient responses, reinforced by qualitative observations. In general, patients were satisfied or very satisfied with service provision across all of the centres studied. MRI staff in the UK were rated slightly better than their counterparts in Europe, specifically on issues relating to staff and patient interaction. Furthermore, MRI staff in the UK were rated as "very professional" compared with "professional" in other countries. In contrast, CT scanning staff were rated as "very professional" in all countries. Across Europe the wide variance in MRI and CT organization and provision had little impact on patient satisfaction. These results will be discussed with reference to waiting times, facilities and radiology staff skills.

1140
Radiology day beds within the department: a cost/benefit analysis
I G H Renwick, I Glaves, J Brooke and M Wild
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PURPOSE: To assess the financial implications of creating exclusive radiology day beds within the department. METHODS: In the summer of 1997, a redundant changing area within the radiology department was converted to a bed bay and two beds installed allowing angiography and certain interventional procedures to be performed as day cases without the need for an overnight stay in a

ward bed. Cancelled cases and resultant wasted staff time can be theoretically avoided. The costs of this development are analysed and compared with the savings in terms of reduced use of acute beds and reduced cancellations. Scope for further potential savings is demonstrated as well as the non-financial benefits to patients and staff. CONCLUSION: Radiology day beds can provide significant savings if used to their full potential but have other logistic benefits to patients and staff.

1150
Seven day radiology — The Torbay experience
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Department of Radiology, Torbay Hospital, Lawes Bridge, Torquay TQ2 7AA, UK
Torbay Hospital is a 650 bed district general hospital which, with the 10 smaller peripheral hospitals in the South Devon Healthcare Trust, serves a community of 280 000. All surgical and medical specialities are provided with the exception of neurosurgery, cardiothoracic surgery, plastic surgery and renal medicine. The Radiology Department at Torbay comprises eight consultant radiologists and 35 whole time equivalent (WTE) radiographers. All imaging modalities are available on-site, including spiral CT and MRI. In November 1997 a seven day radiology service was set up as part of a major initiative to improve the management of emergency cases. A consultant radiologist is present within the Radiology Department throughout both weekend days, with the support of two additional radiographers. Cases requiring an urgent radiological opinion or investigation can therefore be dealt with rapidly and effectively. Semi-urgent and routine in-patient work is also performed, along with a small number of out-patient investigations. In return for working the four weekend sessions, the radiologist has eight weekday sessions off in lieu. The service has proved successful; the proportion of emergency cases being admitted has fallen from 87% to 72% and the average duration of their hospital stay has fallen from 8.2 to 6.5 days. A number of other advantages of seven day radiology has also emerged, and it is anticipated that the service will continue at Torbay indefinitely. The presentation will illustrate the practical and financial implications of the service, both to the Radiology Department and the Hospital as a whole.

1200
Missed barium enema appointments: why do they occur?
H Craven, J Walker and A Troughton
Radiology Department, Princess Margaret Hospital, Swindon SN4 9JU, UK
PURPOSE: Despite the provision or adequate appointment slots the barium enema waiting lists in our department fail to fall. This study was performed to determine what proportion of available appointments were utilized and the causes of any unfilled spaces. METHOD: During an 8 week period in Spring 1998 the number of potential barium enema appointments were counted and the reasons for unused appointments recorded. RESULTS: There were 528 potential appointments. Only 64% of these were utilized. Of the lost appointments 67% were caused by radiologist or radiographer absences. 19% were owing to late cancellations by medical staff or by the patient. 9% resulted from failure to attend on the day. 3% were due to room maintenance. Patients failed to attend as a result of holiday commitments, family illness, language difficulties, condition improving or worsening, poor communication by the department and as a result of their demise. CONCLUSION: The largest single cause of loss of appointments is unavailability of staff. Since this study we have made greater efforts to cover these absences. 30% of all barium enemas are performed by two trained radiographers. Training further radiographers should increase the departmental flexibility. Improving lines of communication and giving a help desk number to patients should reduce the number of non-attenders. We will repeat the study in 6 months time.

1210
An epidemiological study into back pain amongst diagnostic radiographers
S S A Capel
Department of Radiography, Canterbury Christ Church University College, Canterbury CT1 1QU, UK
PURPOSE: To investigate the incidence and prevalence of back pain in a group of diagnostic radiographers, and compare with other health professions. Causative agents/events of back pain with regard to working practice and health are identified. The value of epidemiologic information in relation to professional practice modifications and education is also considered. The cost of back pain is also evaluated. METHOD: A structured interview with 107 radiographers based at five hospitals in Kent and East Sussex was carried out. Descriptive and inferential statistical analysis of data to identify major trends and findings was performed. Post-coded frame analysis was used to code data. RESULTS: Early indications show there are many work-related activities that are a cause for concern, and standards of training and education in manual handing are variable from one Trust to another. Certain types of imaging are "riskier" than others with regard to back pain occurrence and other musculoskeletal disorders. Despite this, radiographers seem to be a relatively hardy bunch with respect to other occupations in that they have low levels of sickness absence. Some risk factors have been identified, but there are others, such as smoking, yet to be evaluated. 21% of radiographers had received back pain caused by a specific incident at work. 56% had pain since they began working in the NHS, with lower lumbar pain being the commonest. CONCLUSION: Early results have identified many aspects of work conducive to back pain and there is scope for lowering the current incidence and prevalence rates.

1220
Discussion

1110–1200
Scientific Session
Radiotherapy: Quality & Other Issues
Hall 11B

1110
A comparison of fatigue experienced by patients undergoing different radiotherapy regimens
[1]D M Flinton, [2]S Waller, [3]W Game and [2]N Nelson
[1]*Department of Radiography, City University, Rutland Place, Charterhouse Square, London EC1M 6PA,* [2]*Essex County Hospital, Colchester and* [3]*St Bartholomew's Hospital, West Smithfield, London, UK*
BACKGROUND/PURPOSE: Existing literature suggests that most patients undergoing radiotherapy treatment suffer from fatigue. The exact cause of the fatigue is unknown but one suggestion has been that it is caused by disruption to the patients' daily routine and the amount of time taken travelling to and from hospital for treatment. This study compares two disparate fractionation regimes to see if there is a relationship between disruption to daily routine and fatigue. METHOD: The study utilized the multidimensional fatigue inventory (MFI-20) to assess five dimensions of fatigue (general, physical, activity, motivation and mental fatigue). Fatigue levels were measured at three points during treatment and again 4 weeks after treatment had been completed. Statistical comparisons were then made on the fatigue scores of the two fractionation regimes and on the quartiles of travelling time. RESULTS: The results show a gradual increase of fatigue throughout treatment resolving back to pre-treatment levels 4 weeks post-treatment. The dimensions of fatigue that scored highest were general and physical fatigue. On average, the fatigue levels experienced by patients having fewer fractions per week, but a higher dose per fraction, were higher than for patients who received a lower dose per fraction and more fractions a week. No relationship between time spent travelling to and from treatment and fatigue was seen. CONCLUSION: No evidence was found to support the theory that disruption to a patient's daily routine in the form of travelling time or number of weekly visits caused fatigue.

1120
Patients' satisfaction with a pre-treatment information video
[1]C Sheehan, [1,2]M Daly, [2]B Periman, [1]D Stockton and [1,3]R Thomas
Departments of Oncology, [1]*Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ,* [2]*Queen Elizabeth Hospital, Kings Lynn, and* [3]*Primrose Oncology Unit, Bedford, UK*
PURPOSE: An audit of patients in our oncology centres showed that 69% of patients were dissatisfied with the information they received following a diagnosis of cancer. When asked what additional tools could improve information provision, 89% indicated that a video would be very helpful. We therefore established a panel of radiographers, doctors, nurses and patients and made an information film with the help of experienced television personalities. This study re-assessed patients' satisfaction to information

provision and evaluated their response of to the film. The considerable expense for this project was kindly donated by AMGEN, BUPA, Janssen-Cilag and Health Education Publication (HEP). METHOD: 105 patients consented to enter this prospective study immediately after their initial consultation with the oncologist. If chemotherapy or radiotherapy was recommended, they were then given an information video cassette to take home, to view as often as and with whom they liked. 2 weeks into treatment the patients completed a satisfaction questionnaire. Statistical analysed used the Binomial test using a null hypothesis as 50% in each group. RESULTS: 90% of patients were satisfied/very satisfied with the information they received compared with 9% who were not ($p=0.001$). 87% felt the video was helpful/very helpful compared with 13% who did not ($p=0.001$). No patient felt it was misleading. CONCLUSION: We feel the 60% reduction in dissatisfaction achieved since the audit was carried out a year previously, is largely consequent to the introduction of video directed information. The majority of patients found it very helpful and felt it contained the optimal amount of information. So far it has been re-made in Italian and plans are underway to translate it into the ethnic languages of the UK and other European languages. We highly recommend its use, in addition to existing tools, in routine oncology practice. Copies are available from HEP (Tel: +44 (0)1222 403022; email: health.education@btinternet.com).

1130
A simple method for matching electron beams in radiotherapy
A L McKenzie
Medical Physics Department, Bristol Oncology Centre, Horfield Road, Bristol BS2 8ED, UK
PURPOSE: The problem of avoiding "hot" and "cold" spots in the dose distribution at the junction of abutting electron fields is a perennial one. Many solutions have been offered to solve this problem, and generally depend upon widening the electron beam penumbra. This is usually achieved by modifying the applicator design and leaving field gaps or overlaps which depend upon the modifier design. The question is, can a simpler approach be found to control the penumbra width without having to re-engineer the applicators? METHOD: An idea which was originally proposed as a solution to a different problem is resurrected here because it happens to solve the beam-matching problem and because it is very simple to apply. In the 1960s, some centres began delivering electron treatment through a slab of polystyrene attached to the end of the electron applicator in order to raise the skin dose where necessary. CONCLUSION: It turns out that the penumbrae of such beams are widened by the slabs in a predictable way, so that the technique of treating through a slab of material provides a simple, cheap solution to the beam-matching problem, particularly as it is generally not even necessary to introduce a gap or overlap between the abutting edges. Examples of the use of these "beam spoilers" in practice will be given.

1140
An intercomparison of two types of beam direction shell used for the treatment of macular degeneration
R Harris and N Blackler
The Plymouth Oncology Centre, Derriford Hospital, Plymouth PL6 8DH, UK
Radiotherapy of the head and neck region requires good fixation and immobilization owing to the close proximity of vital structures. 3 years ago a questionnaire on the use of immobilization devices within radiotherapy centres revealed that 100% of the UK respondents were still utilizing traditional vacuum-formed acetate shells for radical head and neck treatments and 38% occasionally used a commercial thermoplastic device for palliative work. The international respondents appeared more confident with regard to the accuracy of the newer thermoplastic products, with 58% using these devices for radical work, referencing studies which concluded no substantial difference in accuracy. This paper will discuss a study conducted at The Plymouth Oncology Centre to compare and evaluate the accuracy of two different types of fixation device when used for the treatment of patients with the benign eye condition macular degeneration. Patients were randomly selected to be positioned in either a commercially available thermoplastic mask (Orfit™) or a traditional cellulose acetate shell. On each day of the course of treatment a radiographic portal image was employed to ascertain accuracy. Reproducibility of patient set-up was determined by comparing the daily portal image with the original CT scan and verification radiograph. Interfractional set-up deviations were then calculated, assimilated and intercompared for each group. This paper will present the results of the study and discuss the issues of patient positioning, accuracy, implications of costings and changed work practices, and the treatment of a benign eye condition.

1150
Dosimetric evaluation of ultrasound guided iodine-125 implants for prostate cancer
D A Wilkinson, E J Lee, D Mohan and J Ciezki
Department of Radiation Oncology, Cleveland Clinic Foundation, Cleveland, Ohio 44195, USA
As part of the quality assessment of our transrectal ultrasound (TRUS) guided iodine seed implant program for prostate carcinoma, post-implant CT studies are performed on all patients 1–3 days following surgery. From these images, seed positions are identified using our treatment planning software (Multimedia Medical Systems B3DTUI) and the prostate, rectum and bladder are contoured. Cumulative dose-volume histograms are then generated for all of these structures. Analysis of nearly 100 patients implanted has shown that the total implanted source strength per unit prostate dimension lies between 13 and 15 air kerma units per cm (10.2 and 11.8 mCi cm^{-1}). The fraction of the target volume enclosed within the prescription dose (144 Gy) is approximately 0.8–0.85 and within 80% of this dose (115 Gy) it is 0.92–0.94. Three-dimensional reconstructions of the contoured structures with isodose surfaces are also used in a qualitative assessment of each implant. A comparison of pre-operative and intraoperative treatment planning will be provided using the parameters described above.

1130–1200
College of Radiographers Presidential Address
Hall 11A

1130
Strength through diversity
J Leighton
X-ray Department, Hope Hospital, Stott Lane, Salford, Manchester M6 6HD, UK
Abstract not received.

1200–1245
College of Radiographers William Stripp Memorial Lecture
Hall 11A

1200
Eponymous Lecture
The management and ultrasound imaging of chronic tendon pathology
D Chapman-Jones
Faculty of Health Science, Canterbury Christ Church University College, North Holmes Road, Canterbury, Kent CT1 1QU, UK
PURPOSE: For the musculoskeletal clinician chronic tendon pathology provides one of the greatest clinical challenges. This is particularly so with the Achilles and supra spinatus tendon. Tendon tissue generally responds poorly to current conservative treatment regimes. The purpose of the clinical trial undertaken was to gain a comparison of functional ability between subjects following a new, non-surgical microcurrent, treatment regimen compared with the present conservative methods available. Diagnostic ultrasound was an essential method of evaluating the clinical outcome, and the efficacy of the modality as a method of monitoring pathological progress was evaluated employing a novel scoring method. MATERIALS AND METHODS: A prospective comparison, randomized control method was employed. It examined the functional outcomes of two groups of 24 subjects, presenting with similar chronic clinical conditions, exposed to different treatment regimes. Group A: current treatment; Group B: new microcurrent treatment. Objective clinical tests and diagnostic ultrasound evaluated the effectiveness of both sets of treatments. Subjective self-assessment was also employed. Subjects were followed up for a minimum period of 1 year, utilizing these tests where applicable. The efficacy of ultrasound findings in relation to clinical assessment was found using a novel scoring system that compared findings with clinical markers. This was evaluated using the Spearman Rank correlation test.

RESULTS: The Mann–Whitney U-test highlighted statistically significant differences in favour of Group B, the experimental group, in four out of the five markers. A agreement between the diagnostic ultrasound findings and the clinical and subjective assessment was demonstrated with a significance level of 0.76 at a p level of 0.005. CONCLUSION: The appropriate application of microcurrent treatment to a tendon presenting with chronic pathology can make a significant contribution to the clinical management of the condition. A poor response to current methods of current conservative management was shown. A statistical model can demonstrate that diagnostic ultrasound is a suitable modality to assess the progress of this pathology.

1300–1345
Royal Society of Medicine
Finzi Lecture
Hall 5

1300
Eponymous Lecture
Lymph node imaging: the shadowy past, colourful present and bright future
C Metreweli
Prince of Wales Hospital, Chinese University of Hong Kong, Hong Kong
Of all tissues the reticuloendothelial system is the only one whose function is to combat disease. Lymph nodes are a major component of the system and are invariably involved in inflammatory and malignant conditions. Occasionally they are the only clue to the presence of a disease. Their importance in staging and malignancy is emphasized by the TNM system. It follows that diagnostic imaging should be devoting considerable effort to detection and categorization of nodes, but these have been elusive in the shadowy past of conventional radiology. Today, ultrasound, CT and MRI, and scintigraphy are capable of demonstrating normal and abnormal nodes by virtue of morphological features, vascularity and metabolism. Morphological features that have been elucidated are size, shape, number, the presence of necrosis and calcification, and surrounding oedema. These are, however, inferior to the demonstration of metabolic activity which antedates the morphological changes. Metabolic activity is revealed by several different isotopes with scintigraphy and by changes in vascularity demonstrated by colour Doppler ultrasound. It is the combination of exquisite vascular detail and morphology that enables ultrasound to reveal more detail of both normal and pathological nodes, in areas that are accessible to the probe. This colourful present is already of great clinical value. The bright future lies in growing use — not only better detection, diagnosis and staging, but also managing therapy of malignant disease and possible interventions in immunosuppressive conditions such as ageing.

TUESDAY

1400–1515
Scientific Session
Obstetrics & Gynaecology
Hall 5

1400
Invited Review
MRI in female infertility: an imaging step forward?
S J Golding
Department of Radiology, University of Oxford, Oxford MRI Centre, John Radcliffe Hospital, Headington, Oxford OX3 0DU, UK
Sub-fertility is a major cause of personal and marital distress. Once endocrine and male causes of infertility have been excluded, much of the investigation of the female depends on imaging. Radiographic hysterosalpingography and transvaginal ultrasound have established roles in investigating these patients but both have shortcomings. Recently, contrast enhanced sonographic hysterosalpingography has become possible and its role is currently under evaluation. When all these tests have been carried out, up to 10% of couples may remain sub-fertile for unexplained reasons. MRI already has an established role in several of the diseases which impede fertility, notably ovarian disease, endometriosis and uterine lesions or anomalies. The technique has particular advantages over hysterosalpingography and ultrasound but a practical investigation scheme would utilize the advantages of all available techniques. This talk reviews the growing role of MRI in comparison to other available techniques, including a pilot study involving sonographic hysterosalpingography. Given the number of couples who remain subfertile after full investigation, there is merit in exploring new investigational approaches to this problem. Developmental work proceeding in MRI indicates additional utility of this technique; these new initiatives are reviewed.

1430
Infertility: the incidence of proximal tubular occlusion and its treatment by transvaginal recanalization
E O'Grady, P Lloyd, C Roche and E Thwaite
Directorate of Radiology, University Hospital, Lower Lane, Aintree, Liverpool L9 7AL, UK
PURPOSE: To assess the frequency of proximal fallopian tubal occlusion in patients undergoing hyterosalpingography (HSG) for the investigation of infertility, and the outcome for such patients treated by transvaginal fallopian tube recanalization (FTR). MATERIALS AND METHODS: The results for all patients undergoing fluoroscopically guided HSG for the investigation of infertility during a 24 month period were reviewed. The patients undergoing fallopian tube recanalization were reviewed, for technical success and subsequent pregnancy. Fallopian tube recanlization was performed by one radiologist, under fluoroscopic guidance, using the Rosch–Thurmond technique. All cases were performed as outpatient procedures. RESULTS: Of 167 patients undergoing HSG for the investigation of infertility, 21 patients had proximal tubal occlusions. To date nine patients have undergone recanlization with a technical success rate of 89%. The subsequent overall pregnancy rate is 25% (29% for the technical successes). CONCLUSIONS: Proximal tubal occlusion was present in 13% of patients investigated for infertility in this series. Transvaginal fallopian tube recanalization restores tubal patency in around 90% of these patients. With a subsequent pregnancy rate of 25%, fallopian tube recanalization provides an alternative treatment to *in vitro* fertilization for patients with proximal tubal occlusion.

1440
Continuous audit of "lap and dye" following selection by HyCoSy
R L Tetlow, J L Gamble and L W Turnbull
Centre for MR Investigations, Hull Royal Infirmary, Anlaby Road, Hull HU3 2JZ, UK
PURPOSE: Following the introduction of HyCoSy, it was decided that with a theoretical sensitivity and negative predictive value (NPV) of 100% only those patients with one or both Fallopian tubes shown to be occluded at screening would be offered a "lap and dye". The aim of this paper is to present the results of a continuous audit of lap and dye findings. RESULTS: After 3 years 28 patients had been audited. The predicted reduction in lap and dye was 75%, while the actual reduction was 80%. The mean time from HyCoSy to theatre was 73 days $\pm$131 (three patients had lap and dye prior to HyCoSy). The sensitivity of HyCoSy for predicting occlusion was 80%; the specificity was 63%, while the positive predictive value (PPV) was 46% and the NPV 89%. However, in the false positive group where spill was demonstrated, two patients had hydrosalpinx, two had very slow spill and one had filmy adhesions with inflammation suggestive of pelvic inflammatory disease. If these five patients are analysed as true positives, then the specificity becomes 74.4%. Currently, five patients have had spontaneous pregnancies but none where HyCoSy had demonstrated bilateral occlusion prior to lap and dye. CONCLUSION: HyCoSy is an effective screen for lap and dye. Continuous audit of HyCoSy and lap and dye will provide further insight to the functionality of the Fallopian tube.

1450
An *in vitro* study of 3D imaging of the uterine cavity, with surprising findings
R A O Maher, S Golding, P Foster, C Westbrook, T Bowles, D Dobson, S Watt-Smith and S Kennedy
Department of Radiology and Nuffield Department of Obstetrics & Gynaecology, University of Oxford, Oxford OX3 9DU, UK
PURPOSE: As part of a research programme on this subject we have explored, on an experimental basis, 3D imaging of the uterine cavity. METHODS: A suitable dilution of gadopentetate dimeglumine was initially established as 1.25 mm l^{-1}, using a uterine phantom constructed from conventional hypodermic and infusion equipment. Contrast medium of this concentration was then injected into 17 hysterectomy specimens within a few hours of removal.

These specimens underwent MRI using a 1.5 T MRI system, utilizing multislice spin echo sequences and volume acquisition gradient echo images, both selected to provide T_1 weighting. Image data were transferred to a stand-alone processing unit and surface rendered using our own software. 3D images were evaluated to determine the ability of this technique to demonstrate the intrauterine anatomy. RESULTS: 3D imaging illustrated well the shape and size of the uterine cavity and any distortion due to pathology. Demonstration of the Fallopian tubes was not possible, although portions of the intramural tube were seen in three cases; these findings are thought to illustrate spatial resolution shortcomings of the technique. A surprising finding was permeation of the myometrium by contrast medium. This effect varied in its extent and distribution pattern and variation did not correlate with underlying pathology. There was no correlation with the length of time since hysterectomy but this finding appeared to correlate with the duration of exposure to the contrast medium. CONCLUSION: Successful *in vivo* imaging of the uterine cavity may represent a new tool in the investigation of female subfertility. However, the potential clinical impact of contrast medium uptake by the myometrium needs to be established before the technique can be widely used clinically.

1500
The manager's role in minimizing difficulties encountered by obstetric sonographers imparting bad news
R Simpson
City University, Department of Radiography, London EC1M 6PA, UK
This study used qualitative and quantitative methods to identify difficulties experienced by obstetric sonographers when delivering bad news and to suggest ways of addressing these difficulties. Semi-structured interviews were conducted with nine obstetric sonographers at two London hospitals. This was followed by a postal survey of 180 practising obstetric sonographers in England. One problem participants expressed was the constraint of a busy schedule conflicting with the need to spend more time with the recipients of bad news. Difficulty in accommodating this was acknowledged owing to the unpredictable nature of the delivery of bad news and because of the significant number of patients not attending for appointments which already results in time wastage. Where sonographers did not have a private environment in which to communicate bad news this was identified as a major source of difficulty. Sonographers with managers who recognized and addressed the emotional demands of this aspect of their roles found their departments to be supportive environments where they could express and normalize their occasional feelings of psychological distress. This in turn enabled them to tolerate patients' feelings. Ways in which managers could minimize sonographers' difficulties were suggested. These included counselling skills training for sonographers, a protocol specifying how sonographers should proceed following the delivery of bad news, opportunities for peer support, and the provision and positive perception of a counselling service for staff. Managers can therefore support staff by implementing practical procedures and facilities and also by promoting an ethos where problems may be openly discussed.

1510
Discussion

1400–1500
Scientific Session
Breast Imaging 1
Hall 6

1400
Invited Review
Breast MRI—how to do it
L W Turnbull
Centre for MR Investigations, Hull Royal Infirmary, Anlaby Road, Hull HU3 2JZ, UK
Optimal results are achieved using a 1.0 or 1.5 T MR system combined with a dedicated breast coil. After appropriate counselling patients are placed supine on the receiver coil and additional padding, to prevent movement, inserted into the wells as required. Following a localizer scan, imaging is dependent on the clinical question posed. Full coverage of both breasts can be achieved using a 3D fast spoiled grass sequence or equivalent. Thin slice imaging (2.5 mm or less) at a resolution of 0.66 × 0.89 mm is possible within a 90 s acquisition time. Repeated 3D volume acquisition before and after GD-DTPA infusion, allows determination of contrast uptake kinetics. High temporal resolution is currently not possible over the entire breast volume. Limited spatial coverage at a temporal resolution of approximately 12 s is obtained using a 2D fast spoiled grass or equivalent sequence providing 1.33 × 1.33 mm resolution. Bolus injection of GD-DTPA is given after a pre-specified delay with a saline flush to ensure complete delivery. PD images may be acquired pre GD-DTPA to allow calculation of pre-contrast tissue T_1 characteristics, data required for subsequent 3-compartment pharmacokinetic modelling. Repeat 3D sequence post-contrast, either with fat suppression or later subjected to image subtraction, is acquired for morphological information. Analysis of contrast uptake pattern varies according to acquisition technique used but empirical techniques, pharmacokinetic modelling, use of mathematic descriptors and neural networks will be discussed.

1430
Breast MRI using the short TAU inversion recovery sequence: utility in the post-treatment breast
C J Beveridge, R C Cooper, A J Potterton, P T English and A Coulthard
Department of Radiology, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP, UK
PURPOSE: To determine the utility of the STIR sequence in assessment of the breast after conservative treatment for breast cancer. METHODS: 73 consecutive patients attending for routine follow-up after conservative surgery and radiotherapy for unilateral primary breast cancer were imaged at 1.0 T using a dedicated bilateral breast coil. STIR images (rapid acquisition relaxation enhancement (RARE): TI = 130 ms, TR = 4430 ms, TE = 30 ms, ETL7) were acquired axially as part of the imaging protocol. Two radiologists reviewed the STIR images to obtain consensus scores for the appearance of several features, using the contralateral non-treated breast as control. RESULTS: 90 scans were reviewed from 73 patients. Mean interval between treatment and imaging was 52 months (9–160 m). Skin thickening involving the treated breast was seen in just over half of cases (55.5%; 50/90). Over 80% showed increased signal intensity (SI) within the cutaneous tissues (82%; 74/90). Both skin thickening and cutaneous SI declined significantly with time from treatment ($p = 0.05$). SI was increased within breast parenchyma in 81% of patients: 33% showed increased SI in breast fat. SI did not change significantly over time in either tissue. Two-thirds of patients showed increased SI involving pectoralis major; in 78% (47/60) this muscle was atrophic compared with the contralateral side. No significant change in pectoral muscle SI was seen in relation to time from treatment. Ipsilateral pleural signal hyperintensity (55/90:61%) also showed no change with time. CONCLUSION: STIR provides additional information in the treated breast. Increased SI may persist for many years after treatment in some tissues.

1440
Dynamic contrast enhanced MRI in the differentiation of breast tumours: the effect of region-of-interest
G P Liney and L W Turnbull
Centre for MRI, Hull Royal Infirmary, Anlaby Road, Hull HU3 2JZ, UK
PURPOSE: To examine whether an automated "hotspot" is more useful in dynamic contrast enhanced MRI for the differentiation of breast tumours, compared with a whole lesion region-of-interest (ROI). MATERIALS AND METHODS: 121 women with primary tumours were examined using a 1.5 T GE Signa system. Localizing images were followed by 25 T_1 weighted dynamic images using a FSPGR sequence during Gd-DTPA injection (12 s temporal resolution). Two methods of ROI selection were used, the whole lesion-encompassing region and also a nine-pixel square covering the most enhancing part. In both cases, values for percentage enhancement at each time point were calculated. Values for the maximum percentage enhancement, the time-to-maximum and the normalized maximum intensity–time ratio (MITR'), which considers the temporal behaviour of the signal intensity changes, were also calculated. RESULTS: 36 benign and 81 malignant lesions were examined. Maximum percentage enhancement was not significantly different between malignant and benign lesions, but time-to-maximum values were significant for both ROIs. Values of MITR' were greater in malignant lesions but this difference was not significant ($p = 0.096$) using the whole ROI. However, corresponding values with the hotspot ROI were significant ($p = 0.003$). Percentage enhancement from 36 to 61 s post-injection was significantly different using both ROIs and, in addition, with the hotspot ROI the differences between later post-contrast time points (232–256 s) became more significant. CONCLUSIONS: This study demonstrates that ROI selection is an important consideration when applied to dynamic contrast

enhanced breast MRI and may improve the differentiation of primary breast tumours.

1450
Dynamic MRI appearances of breast lesions following fine needle or wide bore core biopsy
[1]B K Shah, [1]P J Matravers, [2]K A Shah and [1]W L Teh
Departments of [1]Radiology and [2]Cellular Pathology, Northwick Park and St Mark's Hospital, Harrow, Middlesex HA1 3UJ, UK
Dynamic MRI up to 12 months post-breast surgery is associated with false positive enhancing lesions. It is generally accepted that needle biopsies (particularly wide bore) should be avoided prior to MRI as any granulation reaction and haematoma may potentially interfere with interpretation. AIM: To evaluate a series of MR images performed following needle biopsies for any evidence of prior intervention and interpretative errors. METHOD: A retrospective analysis of all dynamic breast MRI performed between March and August 1998 was undertaken. Pre-contrast T_1 weighted, dynamic unsubtracted and subtracted T_1 weighted images were obtained. Fine (23 G) or wide bore (14 G) needles were used for cytological and histological sampling, respectively. All images were analysed for any MR evidence of prior intervention such as the presence of abnormal signal due to altered blood as well as interpretative errors. Pathological diagnoses were obtained in all biopsied cases. RESULTS: 16 of the 40 patients examined underwent needle biopsies of 19 lesions (18 wide core biopsies, one fine needle aspiration). Between two and four passes were made and the mean duration between biopsy and scanning was 13 days (range 2–23 days). Five of 19 lesions showed susceptibility artefact (four wide core biopsy, one fine needle aspiration), with biopsy–scan interval ranging from 8 to 21 days. Radiological diagnosis was not compromised in any case. CONCLUSIONS: Susceptibility artefact was seen in five lesions (26%), up to 3 weeks post-biopsy. This did not interfere with the extent of abnormality or radiological diagnosis in any lesion. We conclude that recent wide bore core biopsy should not be considered a relative contraindication to dynamic breast MRI.

TUESDAY

1400–1500
Refresher Course
Chest
Hall 8

1400
Invited Review
Rings, slings and other things
A E Boothroyd
Department of Radiology, Royal Liverpool Children's Hospital, Eaton Road, Liverpool L12 2AP, UK
The true vascular ring comprises a complete encirclement of the trachea and oesophagus. A number of other anomalies cause incomplete encirclement, including the pulmonary sling. Symptomatic vascular rings are rare but important to identify accurately, since failure to treat them may result in death owing to tracheal obstruction. However, if present as an isolated lesion, surgical treatment results in a normal life expectancy. The ring results from a congenital anomaly of the aortic arch and it is essential to recognize which of the wide variety of anomalies is present and whether it is associated with a ring. The embryology and anatomy of both common and rare anomalies will be discussed together with their clinical relevance. Imaging modalities used include the chest radiograph, barium swallow and magnetic resonance. CT, echocardiography and angiography have been used less frequently since the advent of MR. The radiological abnormalities as demonstrated by these differing imaging modalities will be shown with emphasis on the potential pitfalls of each technique.

1425
Invited Review
"Things" that appear in the chest
N M Hudson
Cardiac Radiology Department, Glenfield Hospital, Groby Road, Leicester LE3 9QP, UK
With the recent marked expansion of interventional radiology and cardiology there is an increasing number of different devices implanted within the chest. Radiologists need to be familiar with the normal appearances and to recognize the possible complications, particularly in relationship to MRI. Chest radiograph (CXR) images in patients with stents, tubes, valves, wires and coils will be shown and the implications for these patients discussed.

1450
Discussion

1400–1500
Scientific Session
Head and Neck Imaging 2
Hall 11A

1400
Invited Review
Anatomy and pathology of the suprahyoid neck
J W Casselman
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The anatomy of the different superficial and deep spaces of the suprahyoid neck must be known by radiologists. This anatomy, and most of the pathology in these spaces are today best studied using MR. If one can recognize in which space a lesion is located, then the differential diagnoses can be limited to tumours developing from the anatomical structures normally present in this space. The displacement of the fascial planes between the spaces and of the fat containing spaces, especially the prestyloid parapharyngeal space, helps to distinguish in which space the lesion originated. Moreover, the surgical approach differs for lesions originating in different spaces (*e.g.* parotid/extraparotid). The MR signal intensity can also help to characterize a lesion. However, calcifications inside a tumour and displacement of the styloid process are still better depicted on CT. Most frequently patients present with an already known squamous cell carcinoma and the purpose of the imaging is "staging". Once again, a profound knowledge of the anatomy will facilitate this task. If one can recognize in which space the tumour is situated and if one knows the connections with the surrounding spaces, it becomes possible to predict the most probable extension routes and to recognize early important extensions. This extension will often be along nerves and vessels, fascial planes, bone and muscle surfaces etc. The most dramatic change in staging occurs when involvement of nerves and of bone is found. A T1 or T2 tumour can then suddenly become a T3 or T4 lesion. MR has become the method of choice to detect perineural tumour spread and tumour extension in and along soft tissues. Cortical bone involvement is still best depicted on CT images. However, involvement of the bone marrow can only be evaluated in a reliable way on MRI. Both unenhanced T_1 weighted images and Gd-enhanced fat suppressed T_1 weighted images can be used to detect bone marrow involvement. Finally, lymph node staging is reliable on axial CT images, but is best performed in the coronal plane, using unenhanced T_1 weighted images or Gd-enhanced fat suppressed T_1 weighted images, when MR is used. In conclusion, the radiologist must know the anatomy of the suprahyoid neck in detail in order to recognize which tumour is being dealt with and to recognize early tumour extensions. MR is the method of choice in the evaluation and staging of tumours in the suprahyoid neck. However, CT is still valuable in the detection of cortical bone invasion and intratumoral calcifications and can also be used when MR is not available or possible.

1430
Invited Review
Anatomy and pathology of the infrahyoid neck
J Kabala
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Conventionally the clinician will describe lesions in terms of anatomical triangles. The neck can be considered as two large triangles, the anterior and posterior triangles divided by the sternocleidomastoid muscle. The anterior triangle is divided into four smaller triangles (carotid, muscular, submental and submandibular) while the posterior is divided into the occipital and subclavian triangles. The anatomy of the neck demonstrated on CT and MRI, especially in the axial plane, is easier to describe in terms of fascia lined spaces. There are five identifiable spaces, the visceral, carotid, posterior cervical, retropharyngeal and prevertebral. All except the visceral spaces are present in both the suprahyoid and infrahyoid neck. The visceral space contains several organs important in both imaging and pathological contexts. This space contains the thyroid and parathyroid

glands, larynx, hypopharynx and oesophagus. Thyroid lesions are frequent although fortunately sinister lesions are relatively uncommon. The diagnosis of the latter is essentially cytological or histological with the radiological role being principally related to staging. Parathyroid imaging is almost always a simple (or not so simple) localization exercise. The most important laryngeal/hypopharyngeal/oesophageal lesions are of course carcinoma with a principal radiological role being the demonstration of stage, often a subtle and challenging role. Additionally of course in the upper oesophagus radiology is important diagnostically. Carotid lesions include vascular lesions, neurogenic lesions, developmental lesions such as second branchial cleft cysts and the common lesions of the lymph node chains both inflammatory and malignant. The posterior cervical space has few critically important contents and consequently tends not to be primarily affected by pathology to the same extent as the carotid and visceral spaces. It is the site of developmental, neurogenic and lymph node lesions (both inflammatory and neoplastic), the latter often in association with lymph node pathology in the carotid space. The infrahyoid retropharyngeal space is continuous superiorly with the suprahyoid infrahyoid space and inferiorly into the mediastinum to the level of about the third vertebral body. It is rarely the site of primary origin of disease but serves as a conduit for significant pathology to travel between the neck and the mediastinum. The infrahyoid prevertebral space is similarly continuous superiorly with the suprahyoid prevertebral space and inferiorly extends into the mediastinum, again to around the level of the third thoracic vertibra. The principal source of pathology in this space is usually anterior extension from the vertebral column.

1400–1630
Scientific Session
Bioeffect Planning & Conformal Radiotherapy
Hall 11B

1400
Invited Review
Status of bioeffect planning
C G Orton
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Traditionally, treatment planning in radiation therapy has been confined primarily to attempting to achieve an acceptable dose distribution within the target volume and surrounding normal tissues. With the advent of fast 3D planning computers and sophisticated treatment machines, it has recently become possible to specify what dose distribution is "desired" rather than just "acceptable". This has generated a flurry of interest in development of "tools" to enable the treatment planner to design these "optimal" dose distributions, such as optimization and inverse planning algorithms aimed at maximizing benefit whilst minimizing risk. In conjunction with these, it has been necessary to develop mathematical models that enable the computation of biological effectiveness of radiotherapy treatments from a knowledge of the physical and temporal distributions of dose within the patient. The current status of such bioeffect planning models is the topic of this presentation. There are several types of bioeffect models used in this work. Some are designed to predict probabilities of local control and complications from dose distribution data alone, without consideration of time dependent parameters, such as fractionation and dose rate. Second are bioeffect dose models, used to determine the effect of time, fractionation and dose rate. Finally, there are models that try to combine these. Topics to be addressed include normal tissue complication probability (NTCP) and tumour control probability (TCP) models, dose/volume considerations, including dose–volume histogram reduction schemes, and the linear quadratic plus time model. Potential limitations and practical examples will be presented.

1430
Invited Review
Conformal treatment delivery and verification — how accurate are we?
V Walker
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The rapid advance of computer technology has had an impact on the way in which CT and MRI data can be used to complement each other for radiotherapy planning. For this reason the target volume can be defined more accurately and the high dose volume conformed, allowing escalation of dose and theoretically increasing cell kill, whilst minimizing dose to surrounding normal tissue. Conformal treatments are therefore becoming increasingly more popular for the treatment of disease in several body sites, but the impact of these treatments are significant for a busy department, having implications for both physics staff and radiographers, and also clinicians to a lesser extent. Advances in radiotherapy equipment, such as the introduction of multileaf collimation, have facilitated conformal treatments along with the ability to monitor routinely set-up and patient position using electronic portal imaging devices. This presentation will look at the process of the conformal treatment delivery and verification for various body sites, from the radiographer's perspective, and the implications that this has on routine workload. It will discuss the extra training required in the use of new equipment and how this can be managed. The role of computerized recording and verification will be emphasized. It will also look at the role extension of the radiographer in assessment of portal images and decision making in the movement of fields, which is a significant change in routine practice. The advantages and disadvantages of online imaging will be considered along with the ever present problem of patient immobilization. Finally, the future possibilities and practicalities of dynamic conformal therapy will be presented.

1500
Invited Review
Cost benefit for 3D conformal therapy
S H Levitt
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Three-dimensional conformal radiation therapy (3D-CRT) is a promising new treatment technique based on the principle that improved precision in both tumour definition and dose delivery will enhance outcomes by maximizing dose to the tumour area while minimizing dose to normal tissue. Using a cost-benefit analysis, in terms of outcomes, we first examined the overall risks and benefits of 3D-CRT. We then used the treatment of prostate cancer as a model to compare actual clinical outcomes reported between 3D-CRT and standard radiation therapy (SRT). Our analysis showed that application of 3D-CRT to the clinical setting remains difficult in lieu of the continual difficulties of target definition, and that justification for dose escalation cannot yet be made based on the lack of benefit found, and suggested increased late toxicity, in most of the dose escalation series compared with SRT.

1530
A comparison of coplanar four-field techniques for conformal radiotherapy of the prostate
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[1]*Joint Department of Physics and* [2]*Academic Radiotherapy Unit, Institute of Cancer Research and Royal Marsden NHS Trust, Sutton, Surrey SM2 5PT, UK*
PURPOSE: To determine the most effective four-field coplanar treatment technique for conformal radiotherapy of the prostate only (PO) or prostate plus seminal vesicles (PSV). MATERIALS/METHODS: A series of 6 MV four-field coplanar treatment plans were created for PO and PSV volumes in 10 patients prescribed to both 64 and 74 Gy. The plans were compared using rectal volumes irradiated to 80% of the prescribed dose (V_{80}), normal tissue complication probability (NTCP) for rectum and femoral heads, and tumour control probability (TCP). Femoral head tolerance was designated as 52 Gy to no more than 10% volume. RESULTS: For the PO group, the optimal plan consisted of two anterior oblique and two lateral fields (rectal $V_{80}=23.8\pm5.0\%$ (1 SD), rectal NTCP $=0.9\pm0.3\%$ at 64 Gy). A "box" technique was less advantageous in terms of rectal sparing ($V_{80}=26.0\pm5.8\%$). Similar results were obtained for the PSV group (anterior oblique and lateral fields: $V_{80}=43.9\pm5.0\%$, NTCP $=2.4\pm0.5\%$ at 64 Gy; "box" technique: $V_{80}=47.3\pm5.5\%$). For the optimal plan, the mean TCP at 64 Gy was $52.8\pm2.7\%$ (PO) and $51.2\pm2.7\%$ (PSV), rising to $74.7\pm2.0\%$ (PO) and $73.6\pm2.0\%$ (PSV) at 74 Gy. CONCLUSION: For both PO and PSV treatment, the optimal four-field coplanar plan consists of two lateral and two anterior oblique fields. The oblique fields should be as lateral as possible without exceeding femoral head tolerance, but gantry angles of 35, 90, 270 and 325° (PO), and 20, 90, 270 and 340° (PSV) are suitable for most patients.

TUESDAY

1540

Intensity modulation in breast radiotherapy: Breast Dosimetry Trial Ethics No. 1244

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PURPOSE: This two arm randomized study aims to compare late tissue damage and quality of life assessments of women having breast radiotherapy using conventional planning (CP) *vs* intensity modulation (IM) to create dose uniformity in three dimensions. METHOD: Electronic portal images (EPIs) produce measurements of radiological density which are used to design IM beams. IM is achieved using physical compensators and wedges. Dose distribution planning analysis is carried out on a validated commercial system, using EPID generated outlines to produce 3D distributions. Immobilization is designed to limit patient movement to 0.5 cm. Total dose for tangential irradiation = 50 Gy / 25 fractions daily over 5 weeks. EPIs are used for verification of position and compensator. RESULTS: Dose–volume histogram analysis of 20 patients shows that the mean breast volume receiving > 105% of prescribed dose is 7.3% for CP *vs* 1.3% using IM (range 0.7–30.8% wedge only; 0.0–15.4% IM). Target volume coverage between 95% and 105% increased from 88.8% to 90.4% using IM (mean increase 1.5%). Target volume dose under 90% increased from 0.7% to 2.0%. CONCLUSION: At this early stage it is not possible to determine if the improvements in distributions correlate to a decrease in late complications and an improvement in quality of life but the use of IM produces an improvement in dose uniformity in breast radiotherapy.

1550

The accuracy and reproducibility of a new breast technique — from simulator computer tomography planning to day 1 electronic portal imaging

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This topic concerns the development of an isocentric technique to treat carcinoma of the breast using a symmetric photon beam. Treatment planning and its verification are carried out on a Nucletron Simulator. The CT extension facility available on this equipment is used to take a transverse slice through the centre of the area of the breast to be treated. Transporting the CT slice via the network to the target planning system, the image can be made lifesize, the treatment can be accurately planned, lung depth irradiated determined and isodose distributions placed onto the hard copy image. To check the reproducibility of this technique a comparative study was carried out. This involved the use of electrical portal imaging to measure the maximum lung depth irradiated during treatment and comparison of this measurement with the maximum lung depth irradiated measured from the simulated CT slice. The results of the study confirm the accuracy and reproducibility of this technique. The input of the radiographers concerned proved to be essential whilst developing and analysing this technique and in the education and training within the radiotherapy department.

1600

Evaluation of a Vac-Fix immobilization device in routine breast radiotherapy using electronic portal imaging

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Developments leading to improvements in the 3D dose distribution for patients receiving breast radiotherapy will be of maximum benefit if set-up errors are minimized. The aim of this study was to see if a significant improvement in set-up accuracy could be demonstrated during routine radiotherapy using vacuum moulded bags (Vac-Fix bags) for additional immobilization in conjunction with a purpose built breast board. Each patient in the trial received half their radiotherapy while immobilized by the Vac-Fix device and half while using our standard set-up. To eliminate the possible effects of time trends on the results, treatment was divided into four blocks of about six fractions each, alternating between the two techniques, with patients randomized to select the initial technique. Treatment accuracy and reproducibility were assessed using daily portal imaging. Analysis was in terms of translational and rotational displacements of the portal images with respect to the corresponding simulation image. Comparisons were made between the techniques for each patient and for the group of patients as a whole. Also, participants were requested to complete a short questionnaire aimed at determining which technique they favoured. With 3/4 of the patients treated, a small but significant improvement in set-up accuracy has been demonstrated for all the measured parameters. A summary of the final results together with patient acceptability will be presented. Whatever the outcome of the study, a significant improvement in patient positioning has been achieved by raising awareness (both patient and staff) as a result of daily portal imaging.

1610

Lens and thyroid doses in patients undergoing SMART treatment for acoustic neuromas

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PURPOSE: To determine if a pathological peripheral dose of radiation is given to the lens of the eye or the thyroid gland during linear accelerator based, fractionated stereotactic multiple arc radiotherapy (SMART) of acoustic neuromas. METHOD: An Alderson Rando anthropomorphic phantom was irradiated using beam data from 13 previously treated patient plans which were modified to conform to the new outline. Lithium fluoride dosemeters were positioned on the lateral canthi for the lens dose measurements and at positions approximating the isthmus, left and right lobe of the thyroid in section 9 of the phantom. Reliability of dosemeter readings was established by repeating dose measurements on one plan five times. Dose measurements were then taken for 12 separate plans and for individual arcs of the treatment. The dose for the respective areas was then added to existing CT and screening dose data in order to calculate the total dose to each sensitive structure. RESULTS: Significant variation in recorded dose was observed between the various sites with the right lobe of the thyroid receiving the highest treatment dose with an average dose over 25 fractions of 41.5 cGy; three plans gave daily doses in excess of 3 cGy. The average daily lens dose was 0.46 cGy. CONCLUSION: The dose to the lens and thyroid as a result of SMART treatment was not pathologically significant although trends between plans, and thus some causative factors of peripheral dose distribution, were discovered which could be acted upon to reduce further lens and thyroid dose.

1620

Film dosimetry for intensity modulated radiotherapy

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PURPOSE: We are investigating methods for provision of 3D conformal treatments by intensity modulated radiotherapy (IMRT) within our typical UK National Health Service (NHS) department. An essential aspect of this process is quality control of the delivered beams. IMRT utilizes highly optimized beams with unique cross-sectional profiles, which vary over a 1 cm × 1 cm grid. We are currently using Ellis-type compensating filters cast from cerrabend to produce such beams, in anticipation of dynamic multileaf collimation (DMLC). METHODS: Film dosimetry can achieve fast acquisition of beam profiles; we used the TVS film manufactured by CEA because of its superior dose–response linearity. The film was packed in plastic envelopes for exposure and developed using a manual processor. Initially, over 16 days, the linearity and the reproducibility of film response to known dose was investigated. Film was exposed, under 5 cm of solid water, to a plane 8 cm × 8 cm field on a Varian 600C Clinac with a range of monitor units. All films received a "standard" field as a benchmark. Furthermore, equivalent modulated beam profiles produced by compensators and superposition of conventionally shaped beams were measured. RESULTS: The response of the film was shown to be linear although its absolute response to a standard dose varied unpredictably, although this is not considered a limitation. Results of the later study will be presented. CONCLUSION: The linearity of the film enables its use as a verification tool for IMRT. We have developed a methodology that is transferable to use with DMLC in the future.

1515–1645
Scientific Session
Breast Imaging 2
Hall 6

1515
Invited Review
Breast MRI—role
L W Turnbull
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The role of breast MRI in both sexes currently revolves around the detection, staging and determination of response to treatment of primary, secondary or recurrent tumour. The excellent sensitivity of MR for primary tumours in post-menopausal and symptomatic women is well recognized. The benefits in staging accuracy, *i.e.* determination of tumour margins, presence of multicentric, multifocal and contralateral disease and chest wall invasion are universally appreciated. Several studies now report useful results in patients with ductal carcinoma *in situ*. Recurrent tumour can be detected with an almost 100% sensitivity, despite presence of extensive scarring and equivocal X-ray mammography. Patients with inoperable disease at presentation can be followed up by MRI, although lack of contrast uptake does not universally imply tumour absence. Although the role of MRI in pre-menopausal women is unproven, studies are ongoing to compare early tumour detection rates with conventional X-ray mammography. The specificity of MRI, particularly for small lesions, continues to stimulate research activity, with investigators examining the role of empirical techniques, pharmacokinetic modelling, use of mathematical descriptors, and neural networks to analyse dynamic and static data. MR is a valuable technique for determination of prosthesis integrity whether inserted for reconstructive or cosmetic purposes. Currently, most investigators quote specificity values of 80–90% although lesions such as small highly vascular fibroadenomas, epithelial and ductal hyperplasia and sclerosing adenosis continue to cause diagnostic difficulties. Studies are ongoing examining the role of MRI in radial scars, complex sclerosing lesions, equivocal cytology and the effects of hormonal therapy.

1545
Efficacy of digitized mammograms in the detection of mammographic abnormalities: preliminary findings
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PURPOSE: Screening mammography relies on screen–film radiography of high quality to detect small invasive tumours and high grade ductal carcinoma *in situ* (DCIS). Our aim is to compare the efficacy of digitized mammography to conventional mammography in the detection of mammographic lesions. METHODS & MATERIALS: 100 examinations from a UK Breast Screening Centre were digitised with an 8-bit proprietary film digitizer using a high density charged coupled device (CCD). 50 cases were pathologically proven lesions, of which half were malignant. Both the conventional mammography examinations and soft copy digitized examinations were interpreted independently by two experienced mammographers in the USA. The digitized examinations were interpreted on a 2K high resolution monitor. RESULTS: A total of 14 lesions (12 microcalcifications and 2 stellate lesions) was not seen on digitized images that were detected on film mammography, of which five were cancers. All lesions seen on digitized images were seen on conventional film mammograms. No masses were missed on digitized images that were seen on conventional film mammograms. CONCLUSION: This preliminary study demonstrates that digitized mammography is of equivalent efficacy in the detection of masses. However, microcalcifications were better seen on film mammography compared with 8-bit digitized images. We believe that a larger study utilizing higher digitization levels is essential to evaluate digital mammography as an interim solution on the road to full-field digital mammography.

1555
Mammographic location of breast cancer
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It has been observed anecdotally that breast cancers occur most frequently in the upper outer quadrant of the breast on mammograms. This information is of little use to those developing computer aided mammography systems. We have performed a quantitative analysis of the locations of breast cancer in screening mammograms. The information was encapsulated in a model which can then be used to predict the most probable location of malignancy in any given mammogram. A chronological series of 120 mammograms with biopsy proven malignancies has been obtained from the Manchester Breast Screening Service. We have annotated each mammogram to show major anatomical landmarks, the outline of any glandular regions and the outline of the lesion. The annotations have been digitized and then warped to match a mean breast shape. A single map showing the sites of occurrence of all the lesions has been produced. By placing a Gaussian at the centre of each lesion, a probability distribution of the lesion sites on the mammogram has been approximated. The prime motivation for this research is to enable us to produce realistic sets of mammograms for a computer assisted learning system, thereby enabling the placement of synthetic lesions at appropriate sites in normal mammograms. The statistical information in the distribution map can be related to a new mammogram by first fitting the breast shape model to features extracted from the new image, then matching the sites of occurrence map to the new shape.

1605
Results of stereotactic breast biopsy in suspicious mammographic lesions
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PURPOSE: Determination of the diagnostic accuracy of stereotactic large core breast biopsy in the histological assessment of suspicious mammographic lesions. MATERIAL AND METHODS: Stereotactic large core biopsies were performed in 106 patients with a suspicious mammographic lesion; 67 with a mass (55 non-palpable, 12 palpable) and 39 with microcalcifications. Samples were obtained with patients in the prone position under local anaesthesia with a 14 gauge needle and an automated high-speed gun. An average of 4.3 cores per lesion was acquired. In 68 patients (64%) an additional surgical biopsy was performed, 38 (36%) had clinical and mammographic follow-up. RESULTS: In four of the 106 stereotactic biopsies insufficient material for the histological examination was obtained. In the 68 core biopsies with surgical correlation no false-positive, but two false-negative results with regard to the malignancy of the lesion were revealed (sensitivity: 93.8%; specificity: 100%). In the two false-negative results obtained in mammographic lesions judged to be malign, the histology of the stereotactic biopsy showed fibrosis. The stereotactic large core breast biopsy was well tolerated by the patients. No clinically significant complications occurred. CONCLUSION: The stereotactic large core breast biopsy of a suspicious mammographic lesion can be performed with a high diagnostic accuracy. A correlation of the mammographic and histological findings and a follow-up programme are necessary in order to recognize false-negative results early and to avoid a delay in the diagnosis.

1615
Can we be sure about a radiological diagnosis of fat necrosis of the breast?
R Harrison
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PURPOSE: We wished to test the use of ultrasound-guided core biopsy in confirming the diagnosis of fat necrosis of the breast in patients presenting with a breast lump. This technique may provide a prompt safe histological diagnosis, thus obviating the need for surgical excision or follow-up investigations. MATERIALS AND METHODS: We undertook a retrospective review of the clinical presentation, imaging findings and subsequent management of 23 histologically proven cases of fat necrosis. All patients had presented to a specialist breast clinic with a breast lump. RESULTS: All diagnoses were histologically confirmed by ultrasound-guided needle core biopsy, performed at the time of initial presentation. All patients were subsequently discharged. The mean time interval from investigation and biopsy to diagnosis and patient discharge was 5.9 days. CONCLUSION: We showed that ultrasound-guided biopsy of the breast rapidly confirmed a diagnosis of fat necrosis. Such patients may therefore be spared unnecessary radiological follow-up or surgical excision.

1625
Value of image-providing techniques in pregnancy-associated tumours of the breast
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PURPOSE: Owing to physiological changes of the breast during pregnancy and lactation the diagnosis of a palpable tumour is difficult. Approximately 2–3% of all breast cancers coincide with pregnancy, thus an adequate, quick diagnostic procedure is demanded. A delay in diagnosis often results in an advanced state of disease leading to a poor prognosis. MATERIAL AND METHODS: To assess the value of different image-providing diagnostic methods we examined 18 patients (aged 18–38 years) with clinical evidence of breast tumours (1995–1998). The examinations were carried out using real-time ultrasound (7.5 MHz, 10 MHz, 13 MHz), compound ultrasound (Siescape®, Siemens) or 3D ultrasound (logiq 700MR®, General Electric) and colour imaging (colour wave, power wave, composite colour wave) as well as mammography. The method of choice to verify the assumed diagnosis was high speed core cut biopsy (16 G diameter). RESULTS: We evaluated four cases of breast cancer, one case of lymphoma, five cases of adenoma and eight findings typical of lactation. Although sonography proved to be more sensitive than mammography, the specificity was not satisfactory. Colour imaging, 3D or compound ultrasound did not significantly improve the results. CONCLUSION: Using image-providing techniques, diagnosis of pregnancy-associated tumours of the breast is difficult. For early detection of breast cancer (4 out of 18 cases in our study) early core cut biopsy must be recommended.

1635
Discussion

TUESDAY

1515–1645
Scientific Session
New Studies in Chest Imaging
Hall 8

1515
Invited Review
Nosocomial pneumonia: the role of radiology revisited
C J Herold
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Pulmonary infections are among the most frequent causes of morbidity and mortality in the world. In the non-immunocompromised population, pneumonia is the most prevalent community-acquired infection. Mortality in community-acquired pneumonia (CAP) is still considerable, particularly in children and in the elderly population. In CAP, infections occur via person-to-person transmission of micro-organisms bound to or suspended in water — mucus droplets. CAP is commonly caused by gram-positive bacteria *(Streptococcus pn., Staphylococcus aureus)* atypical bacteria *(Mycoplasma pn., Chlamydia)* as well as viruses. Because of the heterogeneous health status of the average out-patient population, infections with mycobacteria, protozoa and fungi may be seen in patients evaluated in private radiology offices and out-patient centres. In CAP, the typical radiological findings include lobar pneumonia, lobular pneumonia (both seen predominantly in bacterial infections) and diffuse bilateral lung disease (more often seen in viruses and atypical bacterial infections). Complications such as necroses, cavitation, bronchopleural fistula, and pleural effusions are more frequently observed in bacterial infections. In the diagnosis and management of CAP, the role of radiology includes detection and/or exclusion of a pulmonary infiltrate, narrowing of the differential diagnosis, guidance of additional (invasive) procedures and patient follow-up. This course will provide a brief review of epidemiological factors, summarise the imaging findings characteristic of CAP, and discuss the role a radiologist may actively pursue in the management of a patient with CAP.

1545
Optimization of spiral CT for detection of bronchial stenoses
[1]P D Edwards, [2]J Curtin, [1]R K Bull and [2]V Brown
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PURPOSE: Determination of optimal spiral CT imaging parameters for measurement of bronchial lumen diameter. MATERIALS AND METHODS: Measurements were obtained from a bronchial "phantom" (five parallel polyethylene tubes embedded in foam matrix with similar radiographic densities to bronchial wall and lung parenchyma). Collimation widths of 1.5, 2, 3 and 4 mm were used with a pitch of 1 or 1.5 and a reconstruction interval of 1 or 2 mm. Images were acquired with the slice plane orientated at 0°, 45° or 90° with respect to the long axes of the phantom tubes. Images acquired at 0° or 45° were transformed into axial images using multiplanar reformatting (MPR). Luminal diameters were measured at lung windows (L: -400; W: 1300) and subsequently compared with known true inner and outer phantom tube diameters. RESULTS: Measurements from images acquired at 90° to the tube long axes were accurate regardless of slice thickness. Images acquired at 0° or 45° only produced accurate measurements at the lowest slice thickness (1.5 mm). Pitch and reconstruction interval had no significant effect on measurement error in any scan plane. CONCLUSIONS: A slice thickness of 1.5 mm or less should be used when assessing bronchial luminal diameters.

1555
Thin collimation spiral CT of bronchi with bronchoscopic correlation
W Bhatti and C Yeong
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PURPOSE: To evaluate the accuracy of thin collimation spiral CT in predicting a bronchoscopically visible lesion. Patients attending for a CT chest in conjunction with bronchoscopy were recruited for a further scan of the bronchi using 2.5 mm collimation, 2 mm reconstruction (Elscint CT Twin helix, 0.7 pitch, scanned in one 30 s breath-hold, from the carina to 100 mm caudad). This is sufficient to visualize the second order bronchial branches distal to the segmental origins in all lobes. Images were viewed axially with coronal/sagittal reconstructions, if necessary by two radiologists who had no knowledge of the bronchoscopic findings. RESULTS: 7/20 patients had normal bronchoscopy (on CT, 4 were normal; 2 had lesions distal of the segmental origins and 1 had a segmental stenosis due to extrinsic nodal compression). 11/20 had bronchoscopically seen lesions which were accurately predicted on CT. In 2/20, there was a discrepancy in identifying the exact segmental origin involved but a lesion was still identified in an adjacent segment. In 1/20, the CT was non-diagnostic due to breathing. CONCLUSION: CT was very accurate in predicting a normal bronchoscopy and did not miss any abnormalities seen on bronchoscopy. CT can accurately predict the need for bronchoscopy and save certain patients the experience of this invasive procedure in which the bronchoscopy will be negative.

1605
Correlation of CT, ultrasound and clinical history in patients with complicated parapneumonic effusions/empyema
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AIM: To determine if CT or ultrasound appearances correlate with the biochemical/microbiological stage of a parapneumonic effusion and whether either technique can predict those patients who will fail medical treatment. METHODS: The radiological features and pleural biochemistry of 50 patients with parapneumonic effusions were assessed. All patients had thoracic CT, and thoracic ultrasound results were available for 36 cases. Ultrasound appearances and CT changes (particularly pleural thickening) were compared with the stage of the effusion and the clinical outcome. RESULTS: *Ultrasound appearances.* Seven (19%) of the collections were anechoic, five (14%), were hyperechoic without septae and 24 (67%) were hyperechoic with septae. No correlation was demonstrated between the ultrasound appearances and the presence of pus, the effusion stage, or the need for surgical treatment. *CT appearances.* All patients had pleural enhancement and the majority had pleural (92%) and extrapleural (72%) thickening. There was a trend for average pleural thickness to increase with the severity of effusion; however, a wide range of appearances was seen. Overall, the thickness of pleural/extrapleural tissues was not significantly related to the stage of effusion or to the requirement for surgery. CONCLUSION: Ultrasound and CT have well established roles in the investigation of parapneumonic effusions; however, neither technique reliably demonstrates the severity of infection or predicts those patients who ultimately fail medical management.

1615
Chest radiograph findings and pulmonary complications in bone marrow transplantation recipients
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INTRODUCTION: To assess pulmonary complications related to bone marrow transplantation (BMT) performed over a 10 year period (November 1986–July 1996) in 352 patients. MATERIALS AND METHODS: Retrospective review of radiographic reports, the BMT database and clinical notes. RESULTS: 148 complications affected 114 (32.2%) patients; 34 (9.7%) of the total transplantation population had more than one pulmonary complication. Infection accounted for 98 (66.2%) episodes. The main categories (with episode numbers) were bacterial (27), fungal (22), viral (17) and protozoan (6). In 26 episodes a specific organism was not isolated, but clinical and radiological improvement followed empirical therapy for the most likely cause(s). The most common bacterial infection was pseudomonas (12). Chest radiograph (CXR) findings were predominantly air space shadowing or nodular opacities. Aspergillosis (17) was the most frequent fungal infection, with the CXR demonstrating confluent air space shadowing, nodules or masses. Cytomegalovirus (14), the main viral pathogen, accounted for diffuse infiltrative opacification and more confluent air space shadowing. Initial radiographs were often unremarkable. Non-infective complications included graft *vs* host disease (11), non-specific pneumonitis (9), pulmonary oedema (5), pulmonary haemorrhage (4), recurrence of primary disease (5) and pulmonary emboli (4). CONCLUSION: Pulmonary complications in BMT recipients are frequent, with infection accounting for the majority. Pseudomonas, aspergillus and cytomegalovirus are the most common organisms within their respective pathogen groups causing pneumonia. Differentiation of the cases of abnormalities on CXRs is extremely difficult and interpretation requires close correlation with the clinical status and other investigation results.

1625
Sarcoidosis or sarcoid-like reactions in patients with malignancy
P J Haggett, Z C Traill and F V Gleeson
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PURPOSE: To review the association and imaging features of sarcoidosis and sarcoid-like reactions in patients with malignancy. MATERIALS AND METHODS: The chest radiograph and high resolution CT (HRCT) scans and clinical findings of nine patients referred for investigation of chest radiograph abnormalities with a known malignancy and subsequently confirmed to be sarcoidosis were reviewed. FINDINGS: The chest radiographs, HRCT scans, histology, and clinical notes of nine patients (six men and three women) referred over a 6 year period were available for review. The histological diagnoses were: germ cell tumour (4), lymphoma (2), breast carcinoma (2) and prostatic carcinoma (1). All patients demonstrated nodularity on chest radiographs, with characteristic HRCT parenchymal appearances in six; nodal calcification was also demonstrated. CONCLUSION: The presence of mediastinal lymphadenopathy and/or pulmonary nodules is not always indicative of metastatic disease in patients with proven malignancy. If the chest radiograph appearances are out of context with the patient's staging an alternative cause such as sarcoidosis or a sarcoid-like response should be considered. HRCT may demonstrate characteristic appearances of sarcoidosis in this patient group and enable a correct radiological diagnosis to be made.

1635
Fast MRI in lung cancer
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PURPOSE: New fast MRI sequences present good opportunities for avoiding respiratory motion artefact and recent reports suggest they may also provide good quality pulmonary MR images. The purpose of the present study is to evaluate possibilities of fast MRI in lung cancer. METHODS: Fast MRI was performed in 24 patients with lung cancer (16 males and eight females aged 39–68 years, mean age 61.24 ± 1.83 years). Modified single breath-hold small tip angle gradient echo (STAGE) sequence with a short examination time (11–22 s) was used on a 0.5 T 'MAGNEX' SMT-50 X/H (Shimadzu) system. Six to 11 images were acquired in coronal, axial and sagittal planes. RESULTS: Fast sequences provided detailed MRI information which was sufficient for the detection of central and peripheral lesions and involvement of adjacent tissues. Owing to the high contrast between pulmonary nodules and lung parenchyma all of them were successfully visualized in all patients with the lung cancer. This also contributed to the reliable staging of lung cancer in all 24 patients. Imaging in coronal, axial and sagittal planes with accurate measurements significantly facilitated needle biopsy in seven patients with peripheral nodules. CONCLUSION: Fast MRI used in combination with the STAGE breath-hold technique can be employed successfully in the visualization of lesions, differential diagnosis of lung cancer as well as in staging and needle biopsy of central and peripheral lung cancer.

1515–1715
Scientific Session
Dose Reduction & Audit
Hall 11A

1515
National CT scanner characterization dose survey
H Kiremidjian, S Edyvean, M A Lewis and A J Britten
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Patient dose calculations from CT examinations can be performed using the National Radiological Protection Board (NRPB) Monte Carlo generated normalized organ dose datasets which were produced in 1991; however, such datasets do not exist for an increasing number of newer scanners (currently over half of the CT scanners in the UK). This study matches these scanners to the older ones by characterizing them in terms of beam quality, tube output and filter shape. 45 sets of data from 29 scanner models were used for the matching process which identifies scanners with similar characteristics. Measurements, following the ImPACT protocol, were performed by physicists at over 30 centres throughout the UK and Europe. The protocol divides the measurements into four parts, each characterizing an aspect of the scanner. Beam quality is characterized by measurements of on-axis half value layer and ratios of computed tomography dose index (CTDI), measured in both standard Perspex phantoms and in air. Tube output is obtained by measuring the on-axis in air dose. Filter shape can be determined by off-axis in air output measurements and also by ratios of phantom periphery to centre CTDI measurements. The CTDI can also be used to establish a dose from an examination to compare with CEC reference doses. Using an in-house developed database, the datasets have been processed and analysed to produce a table of matches for most of the newer scanner models currently in operation in the UK. This allows the substitution of the newer scanners for ones which have a corresponding NRPB dose dataset.

1525
Determining minimum dose for acceptable image quality in CT of the brain by computer simulation
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Objective radiation dose reduction must take account of image quality. Assessment of the relationship of image quality and exposure is difficult since the ideal method is to perform repeat scans at varying mAs. Ethical considerations of repeated exposures only allow a limited number of mAs values to be investigated on a patient group. This work has applied a method by which images corresponding to a range of mAs values may be produced by computer simulation, using a clinical image as the starting point for the simulations. 17 elderly patients undergoing clinical CT brain scans had additional slices for validation of the method: two at the same clinical 420 mAs, and one additional scan at 300 mAs, giving an additional 15% radiation dose for the study. Nine patients were selected who had a low contrast PVLD lesion, with eight controls not having PVLD lesion. Noise was measured from these images, and the 420 mAs image used as the basis for the addition of noise to simulate images equivalent to exposures at 350, 300 and 210 mAs. The simulated images at 300 mAs were compared with the acquired images at 300 mAs. Initial technical evaluation showed that simulated data could not be distinguished from acquired images. Further image evaluation is required to determine the diagnostic difference between images over the range 420–210 mAs, but this work supports the proposal that computer simulation will allow objective reduction of radiation dose with a corresponding assessment of diagnostic accuracy.

1535

Solid state or xenon: CT scanner detector choice revisited

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Modern CT scanners come with many accessories and options which may affect patient doses. One of these options may be the choice of detectors, usually between xenon or solid state detectors. In theory, solid state detectors have an increased efficiency of over 30% so there is a potential patient dose reduction of the same order and this may be a selling point made by manufacturers. At Aberdeen, the Siemens Somatom Plus 4 scanner was installed with xenon detectors and then upgraded in March 1988 to UltraFast Ceramic (solid state) detectors. Thus, there was the ideal opportunity to compare both types of detectors whilst all other factors such as the users or technique preferences remain constant. A comparison on one CT unit has been made of similar procedures carried out before and after the change of detectors. Both sequence and spiral procedures were considered in the comparison. Reductions ranging from 16 to 42% of the original mAs settings were implemented giving corresponding decreases in effective dose of 11–42% with no loss of clinical information. Unlike other comparisons made on detector types used on CT scanners, this comparison was made keeping all user variables constant and on the same CT scanner. This study showed that dramatic dose reductions were achievable using the more quantum efficient detectors.

1545

X-ray frequency survey for the UK in 1998

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A survey has been performed to assess the numbers of all types of radiological X-ray examination conducted in the UK during the period April 1997 to March 1998. The survey covers all diagnostic and interventional procedures using X-rays for medical and dental purposes, both within and outside the National Health Service (NHS), but excludes ultrasound and nuclear medicine. This is the first such national survey since 1983. The results provide an up-to-date picture of the UK pattern of medical X-ray imaging practice and will allow revised estimates of the collective dose to the population from these procedures. The survey has utilized detailed information available from radiology management systems at a carefully selected sample of about 50 English NHS Trusts. Up to 400 different classifications of X-ray procedure were found which have been rearranged into 62 standardized categories based on anatomy and patient dose. Extrapolation of the sample data to the whole of England was carried out using broad NHS statistics (KH12 returns) from the Department of Health for the period of the survey. Additional data have been obtained covering NHS radiology practice in Scotland, Wales and Northern Ireland and also X-ray imaging practice outside NHS hospitals, such as that performed in independent hospitals and by dentists and chiropractors. Results will be presented giving the annual numbers of imaging procedures in various categories and recent trends will be identified by comparison with the results from earlier surveys.

1555

Irish reference dose levels for common diagnostic X-ray examinations

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Patients undergoing a diagnostic radiological procedure must have the assurance that the benefits of medically employed ionizing radiation are greater than the risks to them and/or their descendants as a result of any exposure. Recognized constraints of radiation doses provide a framework for this to be achieved. With the implementation of the European Commission Patient Protection Directive (1997), it will be obligatory by May 2000 for each EU Member State to promote the establishment and use of their own diagnostic reference dose levels and ensure that local reviews are undertaken when reference levels are consistently exceeded. Although EC and UK reference levels have been published, these mandatory dose reference levels have not been established in Ireland. The aim of this study is to establish a baseline for current national dose levels for four common diagnostic X-ray examinations that make the largest contribution to the collective dose of the Irish population. For this to be achieved the entrance surface dose was measured on 60 patients in 16 randomly selected hospitals using thermoluminescent dosemeters. Results demonstrated significant intrahospital and interhospital differences between radiation dose and radiological practices. For example, doses to the pelvis varied up to a factor of 45 and not all hospitals were using rare earth screens. Also highlighted were significant differences and similarities between reference dose levels and radiographic systems in Ireland and the UK. This study has emphasized the requirement for measurable and realistic standards in radiation doses in Ireland and has provided a baseline for national reference dose levels.

1605

The evaluation of radiation dose and image quality on modern mobile image intensifier systems

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A comparative assessment was made of a number of modern mobile C-arm mobile image intensifier systems. A series of performance tests was carried out on each unit, including measurement of radiation dose and image quality. The imaging performance was evaluated using typical threshold detectability test objects as well as an objective assessment of limiting resolution, field size and image geometry. Maximum and typical patient doses and the input kerma to the image intensifier were measured. Additionally, compliance with appropriate requirements and legislation covering electrical, mechanical and radiation safety was checked. A contrast detail detection index was derived directly from the contrast detail diagram. This index is independent of input air kerma to the image intensifier, although a modifying factor to account for input dose could be applied. A comparison is made with existing figures of merit already described in the literature and with other performance indicators. The index is designed to provide a simple and direct method of comparing image quality. The measured patient doses on all units assessed comply with recommendations given in current guidelines. In terms of image quality, the modern mobile image intensifier systems do not show a significant improvement with respect to older reference systems. The results also indicate that image intensifier input dose levels on modern systems are generally lower than for earlier generation units.

1615

Comparing the performance of uni-planar and bi-planar systems in neuroangiography using dose–area product

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PURPOSE: To identify any significant difference in dose–area product (DAP) when cerebral angiography is performed on two different systems. MATERIALS AND METHODS: A retrospective analysis of dose data from 266 cerebral angiograms was performed. The angiograms were carried out at the National Hospital for Neurology and Neurosurgery between June 1997 and August 1998. 128 of the procedures were performed using a uni-planar system and 138 using a bi-planar system. Both systems were operating at optimal performance as designated by the manufacturer. All procedures were carried out by the same group of operators. The mean, standard deviation and range of dose–area product and fluoroscopy times were calculated for both units. Data were compared using Student's *t*-test. A level of $p<0.05$ was taken as significant. RESULTS: The mean DAP values for cerebral angiography were 3940 cGcm^2 for the uni-planar system and 4511 cGcm^2 for the bi-planar equipment. Corresponding standard deviations were 3227 and 4432 with ranges of (732–26392) and (486–27848). Student's *t*-test showed no significant difference between the two systems. CONCLUSION: There was no significant difference in dose–area product values or screening times between the systems. The more modern bi-planar system did not show a significant reduction in radiation dose compared with the older uni-planar system. This study therefore shows no dose advantage of using a bi-planar system. The bi-planar system also showed no significant reduction in screening time.

For Work in Progress contributions to this session see p. 92.

TUESDAY

1530–1700
Special Focus Session
Film Viewing
Hall 5

Wednesday 19 May

0815–0915
State of the Art Symposium
Pelvic Floor and Fistula Imaging
Hall 5

0815
Invited Review
MRI defaecating proctography
W Gedroyc
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The new generation of open magnetic resonance machines is allowing a new range of procedures to be developed, utilizing the improved vertical and horizontal access available for patients. This means that patients can now be imaged in an upright sitting position in some units, allowing not only different planes of imaging, but permitting soft tissue movement assessment using rapid gradient echo images in these positions. We have examined a technique of MR protography using such a seated position in an interventional (GE Signa SP 0.5T) magnet. We describe our initial experience with the development of this technique and its use in an early pilot sample of patients, and how the early results will be expanded into comparative studies.

0840
Invited Review
Functional pelvic floor imaging
S Halligan
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Pelvic floor dysfunction may elicit symptoms of urinary or faecal incontinence, constipation, pelvic pain and feelings of incomplete evacuation. Diagnosis and management of anal incontinence is relatively straightforward and uncontroversial, in contrast with other forms of pelvic dysfunction. This review will describe how anal sphincter imaging is used to diagnose either anal sphincter laceration or idiopathic degeneration as a cause of faecal incontinence, employing anal endosonography and magnetic resonance. The two techniques will be compared and contrasted. The procedure and clinical relevance of evacuation proctography for the diagnosis of constipation and visceral prolapse will also be described, along with details of modified techniques such as cystoproctography, peritoneography and dynamic MR imaging. Its place within treatment algorithms and relevance to clinical management will be discussed along with details of its therapeutic impact. The aim is to give the attendee a broad understanding of the possibilities and clinical relevance of functional pelvic floor imaging rather than to describe minutiae of technique and anatomy.

0905
Discussion

0830–1000
Scientific Session
Advances in Neurovascular Radiology 1
Hall 8

0830
Invited Review
Endovascular treatment after aneurysmal subarachnoid haemorrhage
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The last decade has seen the introduction of coil embolization for the treatment of intracranial aneurysms. The recent expansion of its indications and use can be dated to the introduction of a controlled detachment coil which relies on electrolysis of the junction between the platinum implant and a steel control wire. This lecture will describe a detailed audit of 317 patients treated acutely after aneurysmal subarachnoid haemorrhage over 5 years (1992–97) and followed for up to 6 years. Treatment outcomes, early and after 6 months were comparable with conventional microsurgical clipping of ruptured aneurysms; procedural morbidity occurred in 3.2% and mortality in 3.5% of patients and 6 month outcomes (Glasgow outcome scores) were GOS 1 or 2 in 81.5%, GOS 3 in 16%, GOS 4 in 3.5% and 5% of patients died. No rebleeding occurred within the first 6 months of treatment but 5 patients have experienced late rebleeding, at annual rates of 0.6–2.4%. Crucial to the efficacy of this treatment is the protection provided against re-haemorrhage. Rebleeding was related to aneurysm recurrence occurring in 7.9% of angiographically unstable occlusions and only 0.4% of those aneurysms with stable occlusion. The results demonstrate that this form of minimally invasive therapy can be performed acutely after SAH and that patients in poor clinical condition did particularly well, when compared with historical surgical outcomes. The results are now being tested in a randomized controlled trial (International Subarachnoid Aneurysm Trial, ISAT).

0900
Spectrum of MRI abnormalities in neurosarcoidosis
D Pickuth, S H Heywang-Köbrunner and R P Spielmann
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PURPOSE: Clinical studies report a rate of 5% and autopsy results a rate of 25% of brain involvement in sarcoidosis. The aim of this study was to evaluate the role of MRI in the diagnosis of patients with neurosarcoidosis. MATERIALS/METHODS: The MRI brain scans of 22 patients with sarcoidosis were retrospectively reviewed, along with the clinical information that was provided in the request form. All patients had signs and symptoms referable to the head and were examined with gadolinium enhancement. RESULTS: Cranial (facial) nerve paralysis was the most common clinical manifestation identified in 10 patients. A wide spectrum of MR findings was noted: periventricular and white matter lesions on T_2W spin echo images, mimicking multiple sclerosis (10 patients); multiple supratentorial and infratentorial brain lesions, mimicking metastases (8 patients); solitary intraaxial mass, mimicking high grade astrocytoma (2 patients); solitary extraaxial mass, mimicking meningioma (1 patient); leptomeningeal enhancement (8 patients). CONCLUSION: Neurological involvement is a significant cause of morbidity and mortality in patients with sarcoidosis. MRI shows a wide spectrum of brain abnormalities associated with neurosarcoidosis. These findings, however, are not specific for sarcoidosis and one must consider appropriate clinical circumstances in arriving at the diagnosis. In selected cases with isolated brain involvement, meningeal or cerebral biopsy may be required.

0910
Distribution of cranial MRI abnormalities in patients with symptomatic and subclinical CADASIL
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INTRODUCTION: Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) is a rare cause of inherited stroke and dementia. This study presents the detailed cranial MRI appearances in members of a single family suspected of having CADASIL. METHOD: 19 members of two generations of one family underwent cranial MRI. Scans were evaluated for the presence of atrophy, ischaemic change and infarction involving anatomical subdivisions of the brain. Subcortical and periventricular signal abnormality was noted in relation to number and site of lesions. Patients were tested for presence of the CADASIL gene mutation. RESULTS: 18/19 consented to cranial MRI. All patients with normal MRI were clinically unaffected. Of eight patients with abnormal MRI, seven were gene positive, of which three were clinically unaffected. Gene results were unavailable for one clinically affected MRI positive patient. Atrophy was uncommon even with large lesion load; no patients had evidence of cortical infarcts and no cerebellar infarcts were noted. Infarcts involving basal ganglia, corpus callosum and brain stem were commonly seen. Subcortical white matter signal abnormality was seen in all eight patients, with 8/8 involving frontal lobe, 7/8 parietal lobe, 7/8 temporal lobe and 3/8 occipital lobe. Confluent periventricular white matter abnormalities were most frequently seen in frontal and parietal lobes. The three clinically unaffected subjects all had some evidence of subcortical signal abnormality. CONCLUSION: This study suggests a distribution of imaging features, which could be useful in differentiating CADASIL from other intracranial vascular pathologies.

0920
MRI in acute neurological emergencies
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PURPOSE: To see if standard and ultrafast MR methods can be used to assess acute neurosurgical and neuromedical emergencies and to compare the diagnostic information gained from CT, standard MR imaging and ultrafast MR imaging in 100 neurological emergencies. METHODS: This was a prospective study of 50 acute neurosurgical and 50 neuromedical cases. The patients had MR examinations as well as routine CT scanning at presentation. The patients were scanned using standard spin echo/fast spin echo sequences and a series of rapid techniques including echoplanar and single shot fast spin echo techniques. All MR examinations were performed on a superconducting 1.5 T system with 27 mT m^{-1} gradients (Edge Eclipse, Picker International). The success rate of scanning these patients was recorded subjectively by experienced neuroradiologists as either of diagnostic quality or not. The CT, standard MR and rapid sequence MR examinations were reviewed by two from a pool of four experienced neuroradiologists in a blinded fashion. The reviewers were asked to make their diagnoses and rate the certainty of diagnosis using visual analogue scales. RESULTS: Indications for referral were: ?ischaemic stroke (24 cases), ?subarachnoid haemorrhage (27 cases), symptoms of raised intracranial pressure ?mass lesion (15 cases), head injury (6 cases), infarction (10) and others (18 cases). For standard MR methods, 41% of patients had all five sequences of adequate technical quality. Using ultrafast methods all five sequences were of adequate technical quality in 81% cases. CT and MR were normal in 28%. MR and CT gave comparable information in 38%. In 32% MR provided extra information or changed the diagnosis. In two cases MR misread subarachnoid haemorrhage seen on CT. CONCLUSION: MR can be used in an acute clinical setting of neurological emergencies with a high success rate, particularly new ultrafast methods, and gives extra information in many cases when compared with CT.

0930
A new scale for assessing white matter low attenuation on CT
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PURPOSE: The pathological basis of white matter low attenuation (WMLA) remains poorly understood but its significance in various dementias is increasingly recognized. We developed a new scale for quantification of the anatomical distribution, extent, grade and overall severity of WMLA. MATERIALS AND METHODS: All slices of hard-copies of 647 CTs were reviewed independently by two experienced observers at window widths/levels of 150/50 posterior fossa and 80/40 supratentorium. The white matter was divided into four regions: anterior frontal, posterior frontal, parietal, occipital. Within each region the extent of WMLA was rated as: 0—none; 1 periventricular only; 2 periventricular and deep white; 3 extension to subcortical white matter. The grade of WMLA was scored as: 0—normal; 1—mild; 2—moderate; 3—severe. Multiplication of the extent and grade scores gave regional severity scores ranging from 0 to 9. Addition of the four regional severity scores gave overall severity scores of 0 to 36. In addition, four degrees of atrophy (none, mild, moderate, severe) with any regional predominance, and the presence of infarcts was recorded. 41 scans were double-read by each observer. Kappa values were calculated for intra- and inter-observer reliability. RESULTS: Each scan required only one minute for assessment. Inter-rater agreement was good (kappa 0.58 for WMLA and 0.8 for atrophy). Intra-rater agreements were good (kappa 0.69 for WMLA and 0.8 for atrophy for observer 1; kappa 0.55 for WMLA and 0.78 for atrophy for observer 2). CONCLUSION: This new scale is quick, simple and reliable but also has the advantages of scoring both extent and grade of WMLA by anatomical region. We are employing it in a large study of neuropsychological and pathological correlates in demented patients.

0940
Validation of quantitative CT perfusion imaging with $H_2{}^{15}O$ PET
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PURPOSE: Assessment of cerebral blood flow on a conventional CT machine without the use of specialized equipment may be useful in acute stroke and head injury. We aimed to validate a single slice CT perfusion sequence with $H_2{}^{15}O$ positron emission tomography (PET) using the sagittal sinus as an input function; a method which avoids unnecessary orbital radiation exposure. METHODS: Eight patients were studied, two patients with gliomas, and six with arteriovenous malformations. The dynamic CT perfusion sequence was performed by acquiring the same slice 10 times over 30 s during a 50 ml bolus of intravenous contrast medium given at a rate of 7.5 ml s^{-1} using a power injector. This CT perfusion slice was co-registered with the PET study using a surface matching algorithm. Regions of interest were produced by five readers, taking care to avoid large vessels. RESULTS: The CT perfusion studies were completed without complication. Co-registration was sub-optimal in one patient. Overall, the correlation between the two methodologies was encouraging with an average r^2 value of 0.524 for individual analyses. When two patients with high flow arteriovenous malformations were excluded the average r^2 value increased to 0.640. CONCLUSION: The results of this CT perfusion methodology are encouraging. Having shown its feasibility, further studies in conditions with lower rates of cerebral blood flow are warranted.

0950
Idiopathic cervical dystonia: evaluation of degenerative changes in patients referred for surgery
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INTRODUCTION: Idiopathic cervical dystonia is the most common form of adult onset focal dystonia. Selective ramisectomy is reserved for patients refractory to conservative measures. The degree of degenerative change in patients referred for surgery has not been recorded in the current literature. METHOD: The upper cervical spine CT scans of patients referred for surgery over a 2 year period 1997–1998 were reviewed. The degree and side of degenerative changes were recorded on a 0–3 scale (0 = normal, 1 = minimal, 2 = moderate, 3 = severe). Clinical information was available from presurgical assessments. RESULTS: 34 patients (16 male, 18 female) were referred for surgical evaluation. There were moderate to severe degenerative changes in 5 (15%) patients at the C1-occipital and C1/C2 articulations and in 14 (41%) patients below the C2 level. Of the latter, 6 had right and 6 left sided torticollis/laterocollis and 2 ante/retrocollis. There was no significant correlation between the severity of degenerative change and sex, age, duration of dystonia and parameters on the Toronto Western Spasmodic Torticollis Rating (TWSTR) scale of severity, pain and disability. There was strong correlation with the side of degenerative change and the type of dystonia ($p < 0.001$): patients with left torticollis/laterocollis more likely to have left sided degenerative changes and *vice versa*. CONCLUSION: The type of cervical dystonia can predispose one to have asymmetrical moderate to severe degenerative change depending on which side the dystonia predominates. This may have clinical relevance if the patient's dystonia improves.

0830–1030
Scientific Session
Advances in Musculoskeletal Techniques
Olympian Suite

0830
Invited Review
Chronic recurrent multifocal osteomyelitis
A G Jurik
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PURPOSE: Chronic recurrent multifocal osteomyelitis (CRMO) is today a well established rare clinical and radiographical disease entity mainly occurring in children and adolescents. Owing to its rare occurrence it is often misdiagnosed, resulting in unnecessary diagnostic and therapeutic procedures. It is therefore helpful to draw attention to the often rather characteristic clinical and radiographic features. MATERIALS AND METHODS/RESULTS: Based on the experience in our institution from 42 patients and a review of the literature, information on CRMO will be presented. This disease

has a characteristic benign fluctuating clinical course. It is predominantly located at tubular bones followed by the clavicle and the spine, and other locations are rare. The findings at conventional radiography typically consist of lytic destruction with surrounding sclerosis adjacent to the epiphyseal cartilage plate in tubular bones, initially lytic destruction in the medial part of the clavicle followed by progressive sclerosis and hyperostosis, and spondylodiscitis-like lesion of the spine. MRI may be of help in the differential diagnosis regarding malignant and infectious osseous lesions. CRMO lesions of tubular bones and the spine exhibit rather characteristic MRI features, but the appearance of early clavicular lesions is quite nonspecific. However, in all sites of CRMO in the skeleton, MRI is valuable in assessing the extent and activity of the lesion, and can be a guide to adequate biopsies, if it is necessary to supplement the diagnostic procedures by microbiological and histopathological examinations to exclude infectious diseases and tumour or tumour-like lesions. CONCLUSION: CRMO is a benign disorder which is often misdiagnosed. It is important to make the diagnosis in order to avoid unnecessary diagnostic procedures and initiate an appropriate therapy.

0900
Radiological assessment of the Charite prosthetic intervertebral disc

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PURPOSE: The collapse of artificial discs into the vertebral end plate, termed subsidence, results in abnormal angulation of the prosthesis. This angulation has been studied to determine if the degree of subsidence seen on the first post-operative film increases with time. METHOD: The angle of the upper and lower component of the Charite lumbar disc replacement in relation to the adjacent vertebral end plate was recorded on the first post-operative radiograph and follow up radiograph. The difference in the measurements was compared by the Student *t*-test, with $p<0.05$ taken as significant. RESULTS: 44 lumbar prosthetic discs in 33 patients were studied over a mean of 16 months (standard deviation (SD) 16, range 1 to 78 months). Mean angle of subsidence of the upper component was 4.7°, SD 3.7°, range 0° to 16°, and of the lower component 4°, SD 4.8° range 0° to 18.5°. The angle of subsidence was greater than 10° in 5 discs for the upper component and 6 discs for the lower. In nearly all cases the posterior aspect of the prosthesis collapsed into the end plate, with anterior collapse occurring in only 2 cases, one of which resulted in a kyphosis where an L3/L4 prosthetic disc collapsed by 18°. There was no statistical difference in the angle of subsidence between the first post-operative and follow up radiograph. CONCLUSION: Subsidence presumably occurs at the time of, or immediately after, the operation and in the short term does not increase.

0910
Power Doppler ultrasound in the assessment of small joint activity in rheumatoid arthritis

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PURPOSE: To evaluate the role of power Doppler imaging in the assessment of disease activity of small joints in patients with rheumatoid arthritis. METHOD: 125 small joints (MCPs/PIPs) of 34 patients referred by rheumatology service were assessed using a 15 MHz probe and Acuson Sequoia 512 ultrasound machine. The degree of synovial vascularity was graded on a scale 0 to 3 (0 = no colour pixels seen, 1 = colour pixels in less than 1/3 of synovium, 2 = colour pixels in 1/3 to 2/3 of synovium, 3 = colour pixels in >2/3 of synovium). ESR, patients visual analogue score (0 to 10) and physician's clinical score were also recorded. 10 patients were reassessed by power Doppler following a short course of steroid treatment. RESULTS: Of 125 joints assessed by power Doppler, 43 joints were graded 0, 33 joints were graded 1, 39 joints were graded 2 and 10 joints were graded 3. There was poor correlation between patient's ESR and power Doppler grade. There was moderate correlation between visual analogue score and joint Doppler grade. In 24% of joints power Doppler demonstrated significant disease activity which had not been diagnosed on clinical examination. Of 14 joints reassessed following steroid therapy there was significant improvement in joint Doppler grade ($p>0.005$). Power Doppler detected therapeutic response earlier than clinical examination, allowing appropriate changes in therapy. CONCLUSION: Power Doppler imaging, a non-invasive and inexpensive test, is a sensitive imaging method for detecting small joint disease activity in patients with rheumatoid arthritis.

0920
Sonographic assessment of shoulder congruity in obstetric brachial plexus palsy

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PURPOSE: To assess the ability of ultrasound to determine the congruity of the shoulder joint in children with shoulder deformity secondary to obstetric brachial plexus palsy (OBPP). MATERIALS AND METHODS: Over a 9 month period, pre-operative ultrasound was performed in 10 children with shoulder deformity secondary to OBPP. All US examinations were performed via a posterior approach in the axial plane, allowing assessment of alignment of the posterior margin of the humeral head with the blade of the scapula. The normal shoulder was always imaged to act as an internal control. The shoulder was diagnosed as being congruent if the posterior contour of the humeral head was in line with the scapular blade and incongruent if the head lay posterior to the line of the scapular blade. Ultrasound findings were then compared with the findings at surgery. RESULTS: Seven shoulders were diagnosed as being incongruent by US and were shown to be so at surgery. Three shoulders were diagnosed as being congruent on US of which two were congruent and one was incongruent at surgery. The accuracy of US for diagnosing incongruence of the shoulder was therefore 90%. CONCLUSION: Initial experience suggests that shoulder US is a simple and accurate method of diagnosing shoulder congruity in children with OBPP and may be able to replace radiography when shoulder location is the only clinical question that needs to be answered.

0930
Pre- and post-operative quantitative evaluation of supraspinatus muscle atrophy in rotator cuff tear with MRI

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PURPOSE: The aim of the study was to investigate the correlation between atrophy of the supraspinatus muscle belly and the size of rotator cuff tear. MATERIALS AND METHODS: 10 healthy volunteers and 30 patients (21 male, 9 female) with full-thickness rotator cuff tear underwent MR examination of the glenohumeral joint (MR-VISION, 1.5 Tesla, Siemens, Erlangen, Germany) before and also 6 months after open surgery performing T_1 weighted spin echo, in addition to T_2 weighted fast spin echo sequences with spectral fat suppression in the oblique-sagittal plane parallel to the glenoid fossa. The size of the rotator cuff tear and the retraction of the tendon were assessed during open surgery. The occupation ratio of the supraspinatus fossa by the muscle belly in the "Y-shaped view" and the tangent sign (line through the superior aspect of the scapular spine and the superior margin of the coracoid) as indicators of muscle atrophy were correlated with the size of the tendon tear. RESULTS: Depending on the extent of the rotator cuff tendon tear in centimetres, the sign of the tangent (negative—muscle belly passes the tangent through the superior border of the scapular spine and the superior margin of the coracoid; positive—muscle belly does not do this) and the occupation ratio (relation in % between the surface of the supraspinatus belly and the surface of the whole fossa supraspinata) the patients were assigned to different groups. 13 patients (43%) with cuff tendon tear up to 2.5 cm showed negative tangent sign and an occupation ratio between 40% and 50%. In the case of 12 patients (40%) with a tendon tear between 2.5 and 5 cm, the occupation ratio was 30–40%, and the tangent sign was negative in 4 cases and positive in 8 cases. In 5 patients (17%) with severe tendon tear (>5 cm) the tangent sign was positive in all cases and the occupation ratio was below 30%. In the volunteers group the tangent sign was negative in all cases and the occupation ratio climbed over 50%. High interobserver and intrasubject reproducibility was achieved. In a follow-up period of 6 months post-surgery no significant change in supraspinatus muscle atrophy (regarding occupation ratio and tangent sign) could be observed. CONCLUSION: To evaluate prognosis after surgery and to select the optimal operative method it is important to create a reliable estimation system for supraspinatus muscle atrophy following rotator cuff tear. The intraoperative size of the cuff tendon tear is in excellent correlation with the severity of supraspinatus muscle atrophy detected by MRI. We therefore suggest a division of muscle belly atrophy using the occupation ratio. Occupation ratio >50%

no atrophy (stage 0), 50–40% slight atrophy (stage 1), 40–30% moderate atrophy (stage 2), <30% severe atrophy (stage 3).

0940

The acceptability and accuracy of MRI in children with acute non-traumatic hip pain

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PURPOSE: The cause of acute hip pain in children can be difficult to diagnose clinically. Despite potential advantages, the use of MRI in its investigation has been limited. We developed a rapid, practical MRI protocol as the primary imaging modality in acute non-traumatic hip pain, and evaluated its acceptance and diagnostic performance. METHOD: Prospective study of 50 children (age range 1–13, median 6) presenting with acute non-traumatic hip pain to A&E. Hip MRI was performed in addition to standard investigations (arthrosonography ± hip radiographs) on an open MR system – Picker Outlook 0.23T, comprising coronal GE T_1 weighted, coronal FSE T_2 weighted and axial IRSE sequences. Parents were asked to complete a questionnaire assessing (on a 10 cm visual analogue scale) the discomfort each test had caused, and to state the preferred imaging modality. MRI quality was assessed and diagnostic accuracy compared with standard imaging methods. RESULTS: Diagnostic MR examinations were obtained in 47/50 children. The IRSE sequence was the most reliable in determining underlying pathology ($p<0.002$, χ^2 test). 42 completed questionnaires were returned. Mean score for patient discomfort was 0.5 (SD 1.61) for MRI and 1.09 (SD 2.18) for standard imaging. MRI was preferred by 33 (78.6%), standard imaging by 6 (14.3%), with no preference expressed by 3 (7.1%). Significantly more parents preferred MRI, $p<0.001$ (McNemar's test). Diagnostic sensitivity of MRI was 0.79 (95% CI 0.68–0.90), specificity 1.00 (0.89–1.00). Sensitivity of standard imaging was 0.70 (0.54–0.86), specificity 0.57 (0.41–0.73). CONCLUSION: MRI is an acceptable and accurate imaging method in children with acute non-traumatic hip pain.

0950

The value of the bow tie sign in the MRI diagnosis of bucket handle tears

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Bucket handle tears of the knee menisci are a clinically important subgroup of meniscal tears, generally requiring arthroscopic intervention. MRI has been shown to be less reliable in detecting these tears than the more common oblique tears. Helpful signs have been described such as the presence of a loose meniscal fragment, the double PCL sign, and more recently a new sign designated the 'bow tie' sign has been reported to be both sensitive and specific. We reviewed our experience of bucket handle tears over a 3 year period, correlating the MRI findings, arthroscopic findings and the presence of the various signs. 107 knees were reviewed: 84 where either MRI or arthroscopy identified a bucket handle tear, 40 where neither had done so, and 3 where a simple tear was identified. All cases were reviewed by a single radiologist with an interest in musculoskeletal radiology blinded to the original results. Each case was assessed for the presence of (1) a loose meniscal fragment, (2) the double PCL sign, (3) the bow tie sign, and (4) the contribution of a 3D-volume acquisition. Overall, the sensitivity of MRI for detection of a bucket handle tear was increased from 44% to 74%, with a positive predictive value of 89% when compared with arthroscopy. The bow tie sign had a sensitivity of 71%, specificity of 62% and positive predictive value of 76%, significantly less than has been previously reported. Best results were obtained by using a combination of standard sequences with the 3D-volume acquisition.

1000

Adequacy of MRI of primary bone and soft-tissue tumours from referral centres

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PURPOSE: To assess the adequacy of MRI performed at referral centres on patients being referred to a specialist Orthopaedic Oncology Service. MATERIALS AND METHODS: MRI examinations of 40 consecutive patients referred from 34 different hospitals over an 11 month period were included (20 males and 20 females with a mean age of 39 years; range 9–84 years). There were 25 suspected primary bone tumours and 15 suspected primary soft-tissue tumours. In 19 cases, the MRI reports were also available and were assessed for content of essential information required by the orthopaedic oncologist. RESULTS: A total of 212 sequences were used with a mean number of 5.3 sequences per patient (range 2–8 sequences). Intravenous gadolinium was administered in 14 cases (35%). Of the bone tumours, 10 (50%) were considered less than ideal owing to the absence of an axial T_2 weighted sequence (6 cases), the absence of a longitudinal T_1 weighted sequence (1 case) or the absence of imaging of the whole bone for possible skip metastases (3 cases). Of soft-tissue tumours, 4 (25%) were considered less than ideal owing to the absence of an axial T_2 weighted sequence (4 cases). The most important failures in reporting were to comment on the relationship of the tumour to the neurovascular bundle and the measured extent of intraosseous tumour from the adjacent articular surface. CONCLUSION: MRIs performed in referral centres are usually adequate and rarely need to be repeated. Radiologists performing such investigations need greater awareness of the information required by the orthopaedic oncologist.

1010

Annular tears: the clinical significance of the high intensity zone on lumbar spine MRI

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STUDY DESIGN: Prospective observational study of annular tears, as diagnosed by a high intensity zone (HIZ) within the annulus on lumbar spine MRI, and correlation with the clinical features. OBJECTIVES: To assess the prevalence of HIZs in patients being investigated for back and leg pain and to determine if there are any clinical features which can diagnose the presence of an HIZ. SUMMARY OF BACKGROUND DATA: Previous studies have shown that the presence of an HIZ is associated with reproduction of a patient's pain on stress discography but to date no study has correlated the presence of an HIZ with the clinical features. METHOD: The lumbar spine MRIs in 156 patients being investigated for back and leg pain were analysed for the presence and appearances of HIZs. The clinical features of those patients with an HIZ but with no evidence of neural compression on MRI were analysed by t-test and Chi-squared test, with $p<0.05$ taken as significant. RESULTS: An HIZ occurred with a patient prevalence of 45.5% and occurred most commonly posteriorly (77%) and posterolaterally (22%) within the annulus. There were no features within the history, functional disability questionnaire or physical examination which allowed a clinical diagnosis of those patients with an HIZ. CONCLUSION: An HIZ is a common finding in patients being investigated for low back and leg pain but the presence of an HIZ does not define a group of patients with particular clinical features.

1020

MRI of osteoarticular tuberculosis

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PURPOSE: The definition of characteristic MR appearances of the different forms of osteoarticular tuberculosis. MATERIALS AND METHODS: 54 patients with different forms of osteoarticular tuberculosis were examined. The group of surveyed joints included knees, hips, shoulders, ankles and elbows. MRI of joints was performed on a Gyroscan-T5II (0.5 T). RESULTS: Two main forms of osteoarticular tuberculosis were revealed — tuberculous-allergic synovitis (22%) and primary-osseous tuberculous arthritis (78%). In all cases joint effects were secondary. Characteristic MR appearances of osteoarticular tuberculosis, including marked synovial hypertrophy, resulting from granulematous inflammation, with subsequent formation of fibrous pannus, presence of heterogenous joint effusion, moderate destruction of articular cartilage, degeneration of ligaments and menisci and bone marrow edema. The characteristic MR appearances of primary-osseous tuberculous arthritis included the presence of large fluid-filled cystic cavities in bone epiphysises (primary tuberculous foci), erosion of the subchondral layer of bones, presence of necrotic bone fragments. Periarticular soft-tissue edema and periarticular tuberculous abscesses were also revealed. CONCLUSION: MR appearances of osteoarticular tuberculosis are non-specific, but some characteristic features of this disease allow differential diagnosis. The practical purpose of using MRI in patients with osteoarticular tuberculosis is to reveal early changes of soft-tissue structures of joints at initial stages of arthritis, when X-ray films are negative. In patients with primary-osseous tuberculous arthritis MRI allows the prevalence of such pathological changes to be defined more precisely, as bone marrow edema, erosions and cystic reorganization of bone epiphyses.

0915–1000
Workshop
Abdominal Fistula Imaging
Hall 5

0915
Invited Review
Abdominal fistula imaging: how I image and manage them
M C Collins
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Abdominal fistulous disease is now less common owing to improvements in surgical management and post-operative care, in addition to advances in the treatment of inflammatory bowel disease. Nevertheless, the radiologist should be in a position to provide precise and thorough imaging in these patients, understanding the requirements of the referring clinician. A team approach is essential in the management of this clinically difficult group of patients. The key principles in the radiological investigation of the patient with suspected fistulous disease are as follows: (1) What is the anatomy of the fistulous tract? (2) What is the underlying disease and what is its extent? (3) Is there associated infection or malignancy? (4) Is there continuity at the site of surgical anastomoses? (5) Is there evidence of distal obstruction? (6) Is there adequate drainage of associated collections/abscesses through the fistulous tract? Fistulography requires meticulous technique so that all tracts and communications are demonstrated in relation to their source. The investigation of internal fistulae requires careful luminal contrast studies. The diagnosis of the underlying disease process will be made using the appropriate imaging tools; persistent fistulous disease should always raise the possibility of underlying malignancy, particularly if infection and inflammatory bowel disease have been discounted. Fistulous disease following recent surgical anastomoses requires detailed luminal contrast studies, with the priorities to confirm the site of leakage, establish that there is continuity at the site of anastomoses and to exclude distal obstruction. Occasionally, the fistulous tract does not adequately drain the associated collection/abscesses and it may be necessary to dilate the tract and introduce a large bore drainage catheter or carry out separate percutaneous drainage. The specific roles of the various imaging modalities including contrast studies, radionuclide imaging, cross-sectional imaging and interventional radiology will be described in the context of abdominal fistulous disease.

0930–1045
State of the Art Symposium
Post-mastectomy Radiotherapy 1
Hall 11A

0930
Invited Review
Meta-analysis of radiotherapy trials
R Peto
Clinical Trial Service Unit, Radcliffe Infirmary, Oxford OX2 6HE, UK
Results on 20-year survival will be presented from the most recent update of the worldwide EBCTCG meta-analysis of the randomized trials of radiotherapy in early breast cancer. Collectively, these 41 randomized trials include some 20,000 women (almost all aged under 70), of whom 10,000 have already died.

1000
Invited Review
Who gets post-mastectomy radiotherapy?
P Barrett-Lee
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Two meta-analyses have, in the past, examined trials of post-mastectomy radiotherapy, but both studies contained patients treated many years ago with very different and now outdated radiotherapy techniques and doses. Both showed a slight increase in cardiac deaths among 15-year survivors who received chest wall radiotherapy, but this was offset by a reduction in breast cancer deaths particularly in the newer trials. Modern radiotherapy techniques are designed to treat the chest wall and exclude the heart from radiation doses above 10% of the prescribed dose, and it might be anticipated that cardiac problems will be reduced in contemporary patients. Recently, several randomized studies have reported a reduction in breast cancer deaths of about 30% in pre- and post-menopausal node-positive patients treated with adjuvant systemic therapy and radiotherapy to the chest wall and lymph nodes, compared with adjuvant systemic therapy alone. Furthermore, local chest wall recurrences after mastectomy are often devastating, and remain uncontrolled in over 60% of patients despite further therapy. Many centres, therefore, employ post-mastectomy chest wall radiotherapy on an individual basis, as a means of preventing local recurrence. There is no evidence that adjuvant alone given to node-positive women is effective in maintaining local control, when the risk of loco-regional recurrence is high. Not all patients are at high risk following mastectomy and the decision to give radiotherapy must be based on estimates of risk. The author will provide guidelines on the use of radiotherapy after mastectomy, to assist each centre to draft local guidelines to ensure a uniform approach within the resources of each breast unit.

1030
Discussion

0930–1045
State of the Art Symposium
The Revision of the Ionising Radiation Regulations
Hall 11B

0930
Invited Review
The need for the revision of IRR85 and regulatory aspects
M K Williams
Radiation Protection Policy Unit, Health and Safety Executive, 2 Southwark Bridge, London SE1 9HS, UK
The Ionising Radiations Regulations 1985 (IRR85) which cover the nuclear, industrial and medical sectors have generally been successful in providing a regulatory framework for restricting the exposure of staff and members of the public to ionising radiation. This is clear from examining trends in doses reported to HSE's Central Index of Dose Information. The regulations have also played a role in the restriction of unnecessary exposure of patients, mainly through the requirement for ensuring that equipment used in connection with medical exposures is fit for its purpose. However, the adoption of the Basic Safety Standards Directive 96/29/Euratom (BSS Directive) and the Medical Exposures Directives 97/43/Euratom (ME Directive) requires the UK to make changes to its legislative framework. The revised Ionising Radiations Regulations are intended to implement the majority of the BSS Directive and part of the ME Directive. They will also take account of experience in the operation of IRR85, leading to improvements in the clarity of legal duties. The revised regulations have been developed after extensive consultation, including the publication of a formal consultation document in February 1998. Overall, the regulations have many similarities with IRR85 and the changes in legal duties, while important, are generally modest. The speaker will outline the main regulatory aspects of the draft regulations likely to affect the medical sector.

1000
Invited Review
Clinical implications of the revision of IRR85 and IRR88
L K Harding
Physics and Nuclear Medicine Department, City Hospital NHS Trust, Dudley Road, Birmingham B18 7QH, UK
The Ionising Radiations Regulations 85 and 88 are to be revised in the light of ICRP guidance and revision of the relevant European Directives. These changes are to be implemented by 13 May 2000. There has been wide consultation in the UK on the draft IRR Revised, and it is clear in well run departments that clinical implications will not be great. Most importantly, however, the dose to workers will generally be reduced to 20 mSv per year, and to the general public 1 mSv per year. Other dose limits relating to the skin, eyes and extremities remain unaltered except that the skin dose must

now be measured over 1 cm^2, and this has practical implications. The limit for category A classified workers is now 6 mSv, and the definition of controlled areas more concerned about risks of significant exposure than arbitrary dose figures. The draft UK Medical Exposure Directive is expected early in 1999. It will differ in many ways from its predecessor, in that it will include other areas in addition to patient exposure. Most importantly are comforters and carers of patients who consent to be exposed to support and comfort such patients. The role of the employer will be enhanced, for example in relation to ensuring that protocols, patient instruction, proper equipment, and audit are all in place. The major role of the referring doctor (prescriber) will be to provide patient information so that the exposure can be justified. This will be undertaken by the practitioner (not always a consultant radiologist) in the light of the expert knowledge on medical exposure. A new factor will be diagnostic reference levels for that particular exposure which have been set prospectively. As is currently the case, practical aspects may be delegated to radiographers, technologists, physicists etc. When dealing with pregnant patients the major responsibility is likely to rest with the practitioner.

1030
Discussion

1015–1145
Best Practice
Imaging Liver Metastases
Hall 5

1015
Invited Review
Imaging liver metastases with ultrasound
D O Cosgrove
Radiology Department, Hammersmith Hospital, Du Cane Road, London W12 0HS

An important goal for the development of grey scale ultrasound in the seventies was as a non-invasive way to detect liver metastases. Substantial success was claimed with metastases appearing variably as echogenic and echo poor masses against the midgrey echotexture of the liver. Some trends emerged in an attempt to correlate these patterns with the source of the malignancy, echogenic lesions for example being associated with primaries in the gastrointestinal tract. However, the limits of ultrasound have gradually become more widely recognized. Small lesions, *i.e.* sub-centimetre deposits and those that are inaccessible (*e.g.* the extreme lateral right lobe), are very difficult to detect; more embarrassingly, mainly larger lesions that are centrally placed which may be obvious on CT or at surgery escape detection, as might have been predicted from the knowledge of the spectrum of echogenicity — if there are strongly and poorly reflective deposits, then we can expect to encounter others that are iso-echoic with the normal liver. Even with careful techniques using high end ultrasound scanners, only about 2/3 of metastases are detected though overall staging is rather more successful because metastases are usually multiple. Problems of specificity have also been increasingly recognized, the most important being the similar appearances of haemangiomas and echogenic metastases. Thus the early hopes of ultrasound in liver staging have only been partly fulfilled and so new methods to close the sensitivity and specificity gaps have been explored. One ultrasound approach is to exploit the better resolution of high frequency transducers by scanning directly onto the exposed liver surface at laparotomy. Intraoperative ultrasound is more sensitive and the specificity problem can be addressed by immediate biopsy so the technique has become routine when liver resection or radical colectomy is planned. Doppler offered another opportunity to improve specificity: broadly when arterial signals are obtained from within a lesion, the suspicion of malignancy is increased but, because many metastases do not give Doppler signals, a negative finding does not help exclude malignancy. The arterialization of flow in malignancy has been exploited with the Doppler perfusion index which has reported excellent sensitivity. Unfortunately it is technically demanding and has not gained general acceptance. The development of microbubbles as affective contrast agents for ultrasound opens further opportunities. The enhancement of the Doppler signals allows smaller vessels to be interrogated but the same limitation to its use for differentiating benign from malignant masses applies. However, the arterial venous shunting that is typical of metastases has been exploited in a new way: by measuring the time taken for a peripheral intravenous bolus injection to appear in the hepatic veins. Normally this takes some 40 s but in metastatic disease the arrival time is hastened. This does not occur with haemangiomas and so this simple functional test may improve specificity and possibly also sensitivity, though this has not been thoroughly investigated to date. Some microbubbles, including Levovist, have a liver specific phase that persists after the blood stream has been cleared. Conventional grey scan and Doppler ultrasound do not detect them but the pulse inversion technique, which depends on the non-linear response of microbubbles to incernation, and colour Doppler stimulated acoustic emission, which depends on microbubble destruction, can detect them. In these modes space occupying lesions appear as defects: conspicuity is increased and new lesions can be detected. The fact that focal nodular hyperplasia also retains the microbubbles can be used to improve specificity.

1040
Invited Review
Imaging liver metastases — CT
J Karani
Radiology Department, Denmark Hill, London SE5 9RS, UK

The best practice should parallel the requirements of the clinical practice applicable to an individual radiologist. For example, the requirements of disease staging in a newly diagnosed colorectal tumour differ from the oncological assessment in gauging response to chemotherapy in a cancer unit. The demands of a surgical practice performing liver resection for metastases are equally different, where inaccurate radiological assessment may commit a patient to a non-therapeutic laparotomy. Nevertheless, there are basic fundamentals of CT technique and interpretation applicable to all these. In defining the "best practice" it is important to state the proven consistent areas of "radiological failure". These are (i) missed lesions in the left lobe, (ii) sub-optimal technique, and (iii) misinterpretation. There are many protocols that will produce reproducible results but it is clear that in the assessment of certain tumours, biphasic studies are mandatory. Metastatic disease from breast kidney and melanoma are illustrative. A further relevant issue that has to be addressed is that autopsy and explanted pathological studies have shown that "incidental" benign lesions, such as cysts or haemangiomas, are present in 25% of "normal" livers. Therefore, not all lesions in a patient with a known cancer are metastatic. Therefore the "best practice" must reliably characterize these lesions. Assessment in a surgical resection practice encompasses all these facets of practice but in addition there is increased requirement for lesion conspicuity and accurate segmental anatomical definition if the potential of this important management approach is to be fulfilled. These issues will form the basis of this presentation.

1105
Invited Review
Imaging liver metastases — MRI
P J Robinson
Division of Clinical Radiology, St James's University Hospital, Beckett Street, Leeds LS9 7TF, UK

Indications for MRI include the early detection of small liver metastases, the differential diagnosis of lesions which are indeterminate on ultrasound or CT, and the pre-operative mapping of segmental and vascular liver anatomy in patients who are candidates for surgical resection of liver metastases. Using specific liver enhancement with superparamagnetic iron oxide particles (SPIO), MRI is now the most sensitive non-invasive imaging technique for detecting small lesions. The optimum sequence for use with SPIO remains controversial. MR techniques for assisting in the characterization of difficult lesions include in-phase/opposed phase gradient echo imaging for fat content, exploitation of magnetization transfer effects with conventional spin echo and turbo spin echo imaging, dynamic gadolinium enhancement patterns, and uptake of SPIO and hepatocyte specific contrast agents (MnDPDP, Gd-BOPTA, Gd-EOB-DTPA). Pre-operative demonstration of segmental distribution of liver metastases can be achieved by dynamic gadolinium enhanced T_1 imaging in the coronal or right anterior oblique projections, a technique which allows the simultaneous display of major liver vessels with normal parenchyma and tumours; alternatively, Gd-enhanced time-of-flight MRA may be used to show vascular anatomy.

1130
Discussion

1015–1145
Controversy Corner
Radiographic Practice in Non-accidental Injury in Children and Child Protection
Hall 6

1015
Invited Review
The role of the radiographer in cases of suspected non-accidental injury
S E Taylor
Royal Liverpool Children's NHS Trust — Alder Hey, Eaton Road, Liverpool L12 2AP, UK
Radiographic findings are likely to play a major role in the assessment of the child who is the potential victim of physical abuse. Imaging will fall into two categories: neuroimaging and the skeletal survey. Depending upon clinical presentation, a decision will be made as to which method of imaging to request initially. In the child who is not neurologically obtunded, the skeletal survey will be the investigation of choice. The need for a full skeletal survey is threefold; it will demonstrate new fractures, detect occult fractures and allow the radiologist to try to date those fractures. The radiographer who does not work in a dedicated paediatric centre will probably approach the task of performing any sort of imaging on a child who is suspected of having received non-accidental injuries with a certain amount of trepidation. It is therefore extremely important that radiographers are both assisted and, to a certain extent, protected by being given a comprehensive framework within which to work. Alder Hey Children's Hospital has a large A&E department and such referrals are frequently received. As a result, a strict framework has been formulated which takes into account guidance given under the Children Act 1989. It includes: (a) a formal training programme; (b) clear guidance in the form of standing instructions; (c) agreed policies and procedures. The method of diagnostic investigation used at Alder Hey in cases of suspected non-accidental injury has been clearly defined and will be discussed in detail to prove its efficacy.

1045
Invited Review
Child protection in radiographic practice — is it more than imaging?
P Hogg, J Sudbery and C Eaton
Radiography Department, University of Salford, Salford M6 6PU, UK
Though the responsibilities of radiographers have been the subject of debate for some years, traditionally the common arguments have largely been related to the imaging process, subsequent image interpretation and patient care specific to the examination. The blurring of professional boundaries, the requirement for multiprofessional working and seamless patient care, and the increasing demands of professional and social obligations have demanded that radiographers start to reconsider their responsibility in many areas of practice. Care of children is a good example of radiographic practice which is likely to develop to a point where duties could extend well beyond those traditionally defined. This presentation will focus on how the care of paediatric patients by radiographers could be approached more holistically. This will take into account radiographic and social factors. The current legislative framework will be explored in brief, and examples of paediatric radiography practice in centres from various UK centres will be examined. Difficulties in delivering a more holistic radiographic service for children will be considered and recommendations will be proposed.

1115
Discussion

1015–1200
Scientific Session
Advances in Neurovascular Radiology 2
Hall 8

1015
Invited Review
Differential diagnosis of brain tumours with MR diffusion and perfusion
M Takahashi
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In order to improve prognosis of patients with brain tumours, accurate differential diagnosis and tumour grading is very important before initiation of therapy. In addition to MR imaging, perfusion sensitive MR imaging with the GE-EPI technique and diffusion weighted imaging with SE-EPI have been applied clinically to brain tumours. Perfusion and diffusion have added important information to routine MR imaging. Perfusion images are obtained on the basis of susceptibility effects after rapid injection of Gd-DTPA. Serial images are obtained with GE-EPI with reconstruction of images of rCBV and rCBF in the tumours. rCBV correlates well with the degree of angiographic and histologic vascularity, thus providing information on tumour grading differential diagnosis. In particular, important information is obtained for differentiation of various histologic types of tumours such as malignant gliomas, lymphomas, low-grade gliomas, and radiation necroses. Diffusion weighted imaging has been developed to observe diffusion of water molecules in the abnormal tissues. Diffusion of water molecules produces signal reduction on MR images. Diffusion weighted images are acquired by using the diffusion weighted multislice SE-EPI with application of motion proving gradient (MPG) before and after a 180 degree pulse. An apparent diffusion coefficient (ADC) can be calculated and reflects Brownian motion of water molecules within the normal and abnormal tissues. The ADC of gliomas correlates well with tumour cellularity, since highly cellular gliomas have smaller interstitial spaces, thus providing smaller ADCs. The minimum ADCs of the high grade gliomas are significantly lower than those of low grade gliomas. In conclusion, it has been shown that perfusion sensitive MR imaging with the GE-EPI technique provides useful information on tumour grading and differential diagnosis. Diffusion weighed MR imaging with SE-EPI is also important for assessing tumour cellularity and grading.

1045
The use of quantitative diffusion weighted imaging in childhood stroke
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Although stroke is primarily a disease of adulthood, it occurs in children with a similar incidence to that of brain tumours, with often devastating consequences. Aetiology is uncertain in many cases. About 80% have cerebrovascular disease, and certain groups of children are at particular risk, such as those with sickle cell disease (SCD). Studies in animal models and in adults with stroke have demonstrated the high sensitivity of quantitative diffusion imaging to the early changes that occur in ischaemia. We have performed quantitative diffusion studies in over 200 children, including acute and chronic stroke patients, and children with SCD (both symptomatic and asymptomatic). Diffusion imaging was performed on a Siemens 1.5T Vision system, using single-shot spin-echo echo-planer imaging. A method for the on-line correction of eddy-current effects was developed to enable the calculation of ADC maps in each of three directions, which were combined to produce maps of the trace of the diffusion tensor. Images covering the whole brain were collected and processed on-line in 3 min, allowing immediate availability. By considering the time course of ADC change in lesions following stroke, this technique has allowed differentiation of acute and chronic lesions, and has enabled the identification of multiple acute events. It has also contributed to our understanding of the mechanism underlying other brain lesions such as those resulting from neurotoxicity. This technique can easily be incorporated into the MR examination of acute stroke, and can make a valuable contribution to our understanding of the aetiology of stroke in children.

1055

Using functional MRI to probe brain laterally in visuo-spatial processing

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Since Broca's initial observation of the role of the left hemisphere in speech, neuroscientists have continued to explore the issue of brain laterality. Received wisdom has it that the right hemisphere is largely responsible for the 'non-language' tasks, and in particular the parietal lobe is deemed the 'seat of spatial processing'. Neurophysiological and lesion studies have shown that the right parietal lobe processes the 'global' and the left the 'local' aspects. To date, it has been difficult to judge what contribution each hemisphere makes in visuo-spatial analysis. Therefore, we modified a classic 'visuo-spatial' neuropsychological task — the Judgement of Line Orientation, originally developed by Arthur Benton in 1976, and applied it to 10 right handed male volunteers aged 16–43, in a functional MRI setting. Gradient-echo echoplanar (EPI) MR images were acquired using a 1.5 T GE Signa System retrofitted with ANMR hardware and software at the Maudsley Hospital, London. In each of the 14 planes parallel to the AC PC line, 100 T_2* weighted images depicting BOLD (blood oxygen level dependent) contrast were acquired with TE = 40 ms, TR = 3000 ms. At the same session, a high resolution IR EPI image series of the whole brain was also acquired in the same plane. Prior to analysis, movement estimation and correction was performed as in Friston et al. The data from all ten subjects were grouped to produce a median image according to Brammer et al. Bilateral superior parietal regions showed the largest areas of cortical activation, with a variance of 0.84, *i.e.* there is no discernible difference between the two sides. We conclude that both parietal lobes play a vital role even in basic visuo-spatial processing.

1105

Transient alteration in blood–brain barrier permeability to Gd-DTPA resulting from carotid angioplasty/stenting demonstrated by MRI

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INTRODUCTION: Transluminal angioplasty followed by vascular stenting is becoming widely used to eleviate the risk of stroke in patients with occlusive carotid disease. The immediate cerebral consequences of altering the haemodynamic input to the brain are not fully understood. This paper reports a novel finding with respect to lepto-meningeal and cortical/neocortical uptake of the MR contrast agent Gd-DTPA. METHOD: Four patients with occlusive carotid disease underwent MR investigation immediately prior to and within 3 h post-angioplasty/stenting. One further patient acted as a control: he did not undergo angioplasty/stent insertion but had follow-up MR 2 h after his initial MR examination. MR imaging was performed on a Picker Eclipse imaging system operating at 1.5T. A fast fluid attenuated inversion recovery (FLAIR) sequence (TI = 1800 ms; TE_{eff} = 96 ms; ETL = 8) produced images pre- and post-administration of 20 ml Gd-DTPA (Magnevist, Schering) during both MR examinations (before and after conventional angiography). RESULTS: Minimal or no enhancement was demonstrated prior to conventional angiography. All patients who underwent angioplasty/stenting demonstrated areas of contrast enhancement following intervention but before administration of the second bolus of contrast, when compared with images acquired pre-intervention. Enhancement of the meninges and/or cortical/neocortical cerebral parenchyma occurred only ipsilateral to the stented artery. No enhancement occurred in the contralateral hemisphere. No contrast enhancement was detected in the control patient. DISCUSSION: Our findings suggest that localized, transient breakdown in the blood–brain barrier can occur during the angioplasty/stenting procedure. Further work is being undertaken to help elucidate the physiological mechanisms leading to this observed enhancement.

1115

Reorganization of sensorimotor function in hemispherectomized children

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Children who have sustained unilateral brain injury early in life may show a remarkable degree of residual contralateral sensorimotor function. It is thought that this reflects the high capacity of the immature brain for cortical reorganization. In this study, we have investigated eight patients (between the ages of 10 and 19 years) who underwent hemispherectomy surgery for relief from seizures; four of the patients had congenital brain damage and four had suffered their initial insult at the age of 3 years or above. All of the patients were investigated 7 years or more after the onset of epilepsy and at least 1 year after hemispherectomy. Sensorimotor functions of both hands were investigated using functional MRI during a passive movement task, somatosensory evoked potentials (SEP) recorded following median nerve stimulation, and behavioural tests including joint position sense, double simultaneous stimulation, and grip strength. With fMRI, two of the eight patients (one with congenital damage and one with damage acquired at the age of 3 years) showed activation in the sensorimotor cortex of the remaining hemisphere with passive movement of the hemiplegic hand. Comparable activation was also seen with passive movement of the normal hand. Reproducible early latency ipsilateral SEP components in the remaining sensorimotor cortex were also seen following median nerve stimulation of the hemiplegic hand in both of these children, and in one of the other six patients with disease acquired at the age of 7 years. The behavioural tests revealed residual sensorimotor hand function in six of the patients, which included the three who exhibited ipsilateral sensorimotor effects on SEP. In conclusion, this study has shown that ipsilateral sensorimotor responses can be demonstrated using fMRI and SEP methods in paediatric hemispherectomy patients. The location of ipsilateral fMRI activation was comparable to that found during normal contralateral movement.

1125

Incidence and appearance of haemorrhagic transformation in acute infarction as demonstrated on susceptibility weighted EPI

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We wish to determine the prevalence and extent of haemorrhagic transformation when susceptibility weighted MRI is used as a screen in patients with an acute cerebral infarct. We carried out a retrospective review of all acute MCA infarcts examined with a standard MRI protocol consisting of T_2 weighted axial, axial echoplanar (EPI) diffusion and susceptibility weighted sequences. In 18 months, 242 acute infarcts were diagnosed of which 146 (60.3%) were within the middle cerebral artery (MCA) territory. 74 patients had lesions of the left MCA and 72 lesions of the right MCA. The majority 83/146 (56.8%) were confined to the superficial MCA territory, 25/146 (17.1%) involved both the superficial and deep territories, while in 38 (26.1%) the abnormalities were confined to the deep MCA (lenticulo-striate) territory. A total of 19/146 (13.0%) patients showed evidence of haemorrhagic transformation. Haemorrhagic transformation was seen in 14/83 (16.9%) superficial lesions, 5/25 (20.0%) of the complete MCA infarcts and in 0/38 (0.0%) of the deep lenticulo-striate infarcts. Scattered petechial haemorrhages were seen in 8 patients. A gyriform pattern was seen in 6. Small focal bleeds were seen in 6, while moderate focal bleeds were seen in 2 patients. No patient showed a large focal bleed. Susceptibility weighted echoplanar MRI appears sensitive to the presence of even small amounts of petechial bleeding within areas of recent infarction. The clinical value of this finding must be determined. In particular whether the demonstration of small petechial bleeds should be a contra-indication to Aspirin or other therapy.

1135

MR imaging findings in hypoxic-ischaemic encephalopathy

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PURPOSE: To analyse the MR1 pattern in hypoxic-ischaemic encephalopathy (HIE) at different time stages. MATERIALS AND METHODS: We studied 15 patients with HIE of known cause. The age of the patients at the time of onset of HIE ranged from 4 days to 70 years. Imaging findings were divided into four stages after the time of onset. Acute (day 1–7; n = 4), early subacute (day 8–14; n = 3), late subacute (day 15–28; n = 3), chronic (>28 days; n = 5). RESULTS: Involvement of basal ganglia was a frequent finding and always associated with an unfavourable prognosis (n = 11). In the acute stage, cerebral edema was prevalent (n = 4 of 4). In the early subacute stage, enhanced T_1-weighted images revealed cortical laminar enhancement indicating necrosis (n = 2 of 2 contrast enhanced studies). In the late subacute stage, unenhanced T_1-weighted images showed laminar lesions of the cerebral cortex and appearance of atrophic changes (n = 3 of 3). In the chronic stage, cortical atrophy proceeded (n = 5 of 5) and periventricular lesions could be identified (n = 3 of 5). CONCLUSION: MRI in HIE demonstrates chronologically changing distinct features. Some of these features may have prognostic importance.

1145
When is mesial temporal sclerosis formed? A study of pathology and 1HMRS in epileptic rats
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PURPOSE: To study when mesial temporal sclerosis (MTS) is formed and the relationship between MTS and 1HMRS findings. MATERIALS AND METHODS: 80 rats were administered 10% pilocarpine i.p. Generalized tonic-clonic seizure was found in 53 rats. They were killed at different times and divided into 5 groups: A, 14 rats, 5–30 min; B, 14 rats, 30 min–3 h; C, 13 rats, 3–6 h; D, 12 rats, 6–60 h; E, 14 rats, without seizure. Temporal lobes were resected for histology and 1HMRS. 1HMRS was done with 400 MHz (Varian) MR Spectrometer. RESULTS: In group A, we found: Nissle bodies decreasing in CA1 and CA3 microscopically, swelling of mitochondria and rough surfaced endoplasmic reticulum (RER) in neurons on electron microscope (EM), NAA decreasing on 1HMRS. In group B, we found: karyoklasis and karyolysis in some neurons in CA1 and CA3, gliosis, slightly degenerating changes in dentate gyrus and CA2 microscopically, reducing of cell organs, RER and ribosomes gliocytes increasing on EM, NAA reducing and Lac increasing on 1HMRS. In group C, we found: severe degeneration and necrosis of neurons in CA1 and CA3 and slight in dentate gyrus, CA2 and temporal cortex, obvious microglial hyperplasia around dead neurons microscopically, NAA and GABA reducing, Lac and Cho increasing on 1HMRS. In group D, the findings of histology and 1HMRS were almost the same as those of group C. In group E, only slight degenerative changes of CA1 and CA3 were found. CONCLUSION: We believe that epilepsy can induce MTS within about 3 h. 1HMRS is very sensitive to detect MTS even before it is really formed, especially NAA.

1155
Discussion

1045–1215
Best Practice
Imaging Spinal Trauma
Olympian Suite

1045
Invited Review
The radiograph
P N M Tyrrell
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The patient sustaining multiple injuries needs full clinical assessment and prompt institution of resuscitative procedures. In the unconscious patient, the spine is usually immobilized and handled with care while attention is given to life-threatening injuries to the head, chest, abdomen and pelvis. It is vitally important that spinal injury is considered and evaluated after the patient has been stabilized. Despite the increasing availability of and access to the more sophisticated imaging techniques of CT and MRI, conventional radiographs remain paramount in the initial imaging investigation of the traumatized spine. Careful clinical assessment in conjunction with plain radiographic evaluation will help to direct the need or otherwise for further imaging. In cases of suspect cervical spine injury, a cross-table lateral radiograph provides a helpful preliminary view which may identify major trauma. A normal cross-table lateral radiograph alone, however, is not sufficient to "clear the cervical spine" and further views will be required. It is mandatory to visualize the cervico-thoracic junction. Careful scrutiny of the radiographs searching for disruption of bony alignment — which may be subtle — and disturbances in soft tissue contour may herald signs of a pattern of injury from which deduction can be made about the mechanism of injury, and thus of expected associated features. It is important to establish whether an injury is stable or unstable since this may determine further management and whether surgical intervention may at some time be required. The radiograph also provides detail about the underlying pre-morbid spine and may highlight features which have rendered the patient particularly susceptible to the type of injury incurred. The role of the radiograph in the initial imaging evaluation of the injured spine and the assessment of stability will be addressed and in particular its complementary role with CT and MRI.

1110
Invited Review
CT in spinal injuries
R Bodley
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Although plain films are still the basis of imaging in spinal cord trauma and MR has an invaluable role in determining the damage to the crucial soft tissues, in particular the discs and the cord itself, CT has a major role to play in assessing the bony integrity of the spine. In A & E Departments there is still controversy about what is a safe examination to exclude significant spinal trauma, and if there is doubt on the plain film findings a limited CT scan focused on the area in question is warranted. With the increasing push towards early mobilization of patients with spinal cord injury, primarily as a result of pressures for cost minimization, there is a trend toward early fixation so the patient can be discharged into rehabilitation institutions. For a rational approach to the most appropriate fixation technique in a given patient, the surgeon needs to have a very accurate idea of bone integrity with knowledge of the state of the vertebral bodies, facet joint location and integrity, posterior element integrity and overall alignment. The most critical feature of the examination is to ensure that scanning includes a normal vertebra above and below any fractures that are found. This information is crucial for the surgeon to plan the surgical approach, *i.e.* whether an anterior, posterior or combined approach is needed, or indeed whether to operate at all. The examination technique is critical and it is necessary to angle the cuts through the bony ring. With spiral techniques this can best be performed by using factors such as 3/4.5/1.5 (*i.e.* 3 mm sections at pitch 1.5 and reconstructions at 1.5 mm) with low dose and straight gantry. The appropriate angled cuts can be obtained using the MPR facility. 3D surface rendering is superficially pretty but of little extra benefit. Without spiral techniques, and MPR, the gantry may have to be tilted at different angles depending on the curvature of the spine. The characteristic features of the unifacet, bifacet and burst fractures will be explored. There will be some discussion about the prediction of stability and the various surgical approaches used.

1135
Invited Review
Imaging spinal trauma: MRI
V Pullicino
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The consequences of a wrong, inaccurate or incomplete diagnosis in instances of spinal trauma can have life-long devastating implications. An awareness of the strengths and limitations of radiology is fundamental in providing best practice. Indeed, despite improvements in technology applied in the diagnosis and assessment of spinal injury (CT and MRI), the attending physician still often feels insecure in the interpretation of injury. An interactive and interdependent approach is presented harnessing plain radiography, CT and MRI in the diagnosis of vertebral bony and soft tissue injury. The role of imaging in determining treatment management protocols is discussed, including the place of MRI in providing prognostic indicators of treatment outcome.

1200
Discussion

1100–1200
State of the Art Symposium
Post-mastectomy Radiotherapy 2
Hall 11A

1100
Invited Review
Current UK practice for post-mastectomy radiotherapy
I H Kunkler
Department of Clinical Oncology, Western General Hospital, Edinburgh EH4 2XU, UK
Post-mastectomy radiotherapy continues to play an important role in the loco-regional control of breast cancer. The recent evidence of a survival advantage conferred by post-mastectomy radiotherapy

in addition to adjuvant CMF in premenopausal women who are node positive or with other 'high risk' factors emphasizes the importance of reaching an evidence based consensus on post-mastectomy radiotherapy technique. Much variation in technique still exists between UK oncology departments. The advantages and disadvantages of current techniques will be discussed. Aspects of radiotherapy technique that will be addressed will include the clinical target volumes, use of bolus to the chest wall, field matching, protection of normal tissues, and the irradiation of the peripheral lymphatics.

1130
Invited Review
Breast set-up
C Beardmore
Berkshire Cancer Centre, Royal Berkshire Hospital, Oxford Road, Reading RG30 1AG, UK
This presentation will aim to examine the range of treatment set-ups for both breast and chest wall radiotherapy employed within radiotherapy departments in the UK. Consideration will be given to patient position, method of localization and just how the physical set-up is achieved throughout a course of treatment. Problems related to treatment set-up plus perhaps any identified solutions will also be discussed. The impact of portal imaging and the development of immobilization at this site will also be considered. The presentation will conclude with a description of a single isocentre technique for treatment of the breast and nodal areas.

1100–1200
State of the Art Symposium
The New Quality Criteria in CT
Hall 11B

1100
Invited Review
Disseminating information about the criteria and promoting implementation
A G Jurik
Department of Radiology R, Aarhus University Hospital, DK-8000 Aarhus C, Denmark
PURPOSE: Radiation exposure to the patient during CT is relatively high. It is therefore important to optimize the dose to be as low as consistent with required diagnostic image quality. An EU working document EUR 16262 has been elaborated with regard to this. METHOD: EUR 16262 provides an operational framework for radiation protection initiatives in which technical parameters required for adequate CT image quality are considered in relation to patient doses, including diagnostic requirements specifying anatomical/diagnostic image quality criteria for six main groups of examination: cranium, face and neck, spine, chest, abdomen and pelvis, and bone and joints (pelvis and shoulder). The usability in clinical practice of the image quality criteria has been evaluated in a multicentre study for five types of examination, comprising 20 of each type of examination: (1) face and sinuses, (2) vertebral trauma, (3) HRCT of the lung, (4) liver and spleen, and (5) osseous pelvis. All examinations were evaluated regarding fulfilment of the image quality criteria (Q-score) by a panel of four radiologists and the radiation doses were estimated as dose–length product (DLP). RESULTS: The Q-score for evaluation of the face and sinuses varied between 94% and 100% and for the osseous pelvis between 76% and 100% with no improvement with increasing DLP. For vertebral trauma the Q-score varied between 50% and 96%, for HRCT of the lung between 81% and 100%, and for examination of the liver and spleen between 44% and 96% with a tendency towards higher Q-scores with increasing DLP. In all regions the DLP was related to the number of slices. CONCLUSION: High radiation dose by CT does not always imply the best diagnostic image quality and it seems possible to reduce the dose, especially regarding imaging of osseous structures, without losing diagnostic information.

1125
Invited Review
Reference dosimetry for CT
P C Shrimpton
Medical Dosimetry Group, National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, UK
PURPOSE: The concept of reference doses is recognized as a useful and practical way of promoting optimization of patient protection for diagnostic medical exposures. As an essential component of the quality criteria for CT published by the European Commission (EUR 16262), a robust methodology has been developed for establishing reference doses for the peculiar conditions of exposure in CT. METHOD: The reference dosimetry is based on measurements in standard head and body CT dosimetry phantoms of the computed tomography dose index made with a pencil ionization chamber ($CTDI_{100}$) and expressed in terms of absorbed dose to air. Appropriate combination of measurements made centrally and peripherally yields the weighted CTDI ($CTDI_w$, mGy). This characterizes the conditions of exposure for a single slice, while the dose–length product (DLP, mGy cm) takes due account of the scope of serial or helical scanning in a complete examination. RESULTS: Reference dose values for these two quantities should represent thresholds to trigger investigations by radiology departments where typical practice, as indicated by mean values of the dose descriptors observed for representative groups of patients, is likely to be well away from the optimum. Initial reference dose values for some common procedures have been set as the third quartiles of survey data from the UK and from a European pilot study of the quality criteria. CONCLUSION: A practical system of dosimetry has been developed to allow comparison of dose during critical review of practice in CT that can also be extended to examinations on children.

1150
Discussion

1200–1245
Eponymous Lecture
COR Stanley Melville Memorial Lecture
Hall 5

1200
Eponymous Lecture
Stereoscopic lithography and the manufacture of customized implants in facial reconstruction
N S Peckitt
Department of Oral & Maxillofacial Surgery, Doncaster Royal Infirmary, Doncaster DN2 5LT, UK
Head and neck surgery involves complex methods of composite reconstruction, which do not replicate the volume and contour of normal anatomy. 'Functional reconstruction' implies replication of the normal volume and contour of both hard and soft tissues, to produce normal form and function of the face, mouth and jaws. Stereoscopic lithography, computer assisted design, and manufacture (CAD CAM) techniques have been successfully utilized with computer numerized control (CNC) milling techniques, to manufacture customized titanium implants in a single stage reconstruction of the maxilla, and dentition, without the use of composite flap cover, following tumour ablation surgery. Reduction in theatre time and personnel, ITU utilization, and earlier patient discharge indicate possible cost savings of £17,000–£19,000 per case in the UK market. Cost savings for purchasers in the United States are as high as $150,000 per case. It is advocated that these surgical techniques are simple and safer than current practice.

1300–1345
Eponymous Lecture
IPEM Douglas Lea Lecture
Hall 11A

1300
Eponymous Lecture
Radiation physics and genetic targeting: new directions for radiotherapy
T E Wheldon
Department of Radiation Oncology, University of Glasgow, Glasgow G61 1BD, UK
Radiation, as a cancer treatment modality, is of limited biological specificity. Targeted radiotherapy, the delivery of radiation to cancer cells by radioisotopes conjugated to tumour-seeking targeting

agents, is a biologically attractive option, but is effective for just a few tumour types (neuroblastoma, lymphoma) for which targeting agents are available. Gene therapy strategies are now being developed for the transfection of 'uptake genes' stimulating the uptake of targeting agents in cells receiving the gene. Typically, innocuous viruses are modified to deliver uptake genes, together with co-transfects 'promoter genes', which cause the uptake genes to be active (expressed) only in cells of certain types. In laboratory models, we are exploring the gene-therapy-mediated uptake of radiolabelled MIGB (by transfection of the noradrenaline transporter gene) and sodium iodide (by transfection of the NA/I symporter gene) in glioma cells and prostate and bladder carcinoma cells. These approaches do not require transfection of every cancer cell in order to cure a solid tumour — cells which have escaped transfection (and therefore do not take up the targeting agent) may be sterilized by radiation 'cross-fire' from transfected neighbours. A new task for radiation microdosimetry is to quantify the cross-fire effect, to compute corresponding efficiencies of gene transfection required for tumour cure, and therefore predict the effectiveness of alternative strategies for gene delivery — and to extend this from model systems to real tumours. In the spirit of Douglas Lea, the analytical approach of physics can be used effectively to illuminate and enhance the newest developments of biology, to the benefit of medicine.

1330–1445
Scientific Session
Hepatobiliary Imaging
Hall 8

1330
Invited Review
Modern approach to correlated imaging of the biliary system
J H Lim
Department of Radiology, Samsung Medical Center College of Medicine, Sungkyunkwan University, Seoul, Korea
Several radiological and endoscopic procedures are being used for the diagnosis and management of biliary tract diseases. As each procedure has advantages and disadvantages, judicious use is required. Irrespective of jaundice, sonography is the procedure of choice as an initial examination for screening; some 80% of biliary tract stones, congenital anomalies and cancers may be detected. CT is required to depict correct pathologic anatomy and extent, or to make a correct diagnosis when sonography is equivocal. CT is also helpful in the evaluation of extrabiliary system such as the liver, pancreas, bowel, and peritoneal cavity. Oral cholecystography is only used as a test for function of the gallbladder. Biliary nuclide scan is used as a test for obstruction of the cystic duct. For detailed pathologic anatomy and extent, a cholangiogram is necessary. As MR technology improves, magnetic resonance cholangiopancreatography (MRCP) is indicated as the next procedure since the procedure is non-invasive. MRCP is the procedure of choice in patients with children, in debilitated patients, in elderly patients, and in patients with previous biliary-enteric surgery. Diagnostic endoscopic retrograde cholangiopancreatography is reserved for patients who need endoscopic interventional procedures such as endoscopic nasobiliary drainage, endoscopic sphincterotomy, endoscopic stone extraction, and endoscopic biliary stent insertion.

1400
Diagnosis and management of common bile duct stones
D Pickuth, S H Heywang-Köbrunner and R P Spielmann
Department of Radiology, Martin Luther University, Halle 06112, Germany
PURPOSE: Routine use of intraoperative cholangiography during laparoscopic cholecystectomy is still widely advocated and standard in many departments; however, it is controversial. We have developed a new diagnostic strategy for the detection of bile duct stones. The concept is based on an ultrasound examination and on screening for the presence of six risk indicators of choledocholithiasis. MATERIALS/METHODS: A total of 120 patients undergoing laparoscopic cholecystectomy were prospectively screened for the presence of these six risk indicators: history of jaundice, history of pancreatitis, hyperbilirubinaemia, hyperamylasaemia, dilated bile duct, and unclear ultrasound findings. The sensitivity of ultrasound and intraoperative cholangiography in diagnosing bile duct stones was also evaluated. RESULTS: For the detection of bile duct stones, the sensitivity was 82% for ultrasound and 100% for intraoperative cholangiography. 20% of all patients had at least one risk indicator. The presence of a risk indicator correlated significantly with the presence of choledocholithiasis ($p < 0.01$, chi-square test). The negative predictive value of the total set of risk indicators was 100%. CONCLUSION: Following our diagnostic method, we would have avoided 80% of intraoperative cholangiographies without missing a stone in the bile duct. This study lends further support to the view that the routine use of intraoperative cholangiography is not necessary.

1410
Detection of choledocholithiasis: comparison of unenhanced spiral CT, ultrasonography, and endoscopic retrograde cholangiopancreatography
D Pickuth, S H Heywang-Köbrunner and R P Spielmann
Department of Radiology, Martin Luther University, Halle 06112, Germany
PURPOSE: To compare unenhanced spiral CT, ultrasonography (US), and endoscopic retrograde cholangiopancreatography (ERCP) in the detection of common bile duct stones. The old technique of intravenous cholangiography (IVC) has fallen into disrepute because of inconsistent bile-duct opacification. CT IVC seems to mask a number of stones and is only recommended when angiographic and three-dimensional reconstructions of the biliary tree are required. MATERIALS AND METHODS: Over a period of 2 years, 82 patients with clinically suspected choledocholithiasis underwent unenhanced spiral CT and US immediately before undergoing ERCP. CT/US scans and ERCP images were evaluated for the presence of bile duct stones, ampullary stones, and extrahepatic biliary dilatation. RESULTS: Unenhanced spiral CT (US) depicted common bile duct stones in 24 (23) of 28 patients found to have stones at ERCP. Five patients had stones impacted at the ampulla, all (two) of which were detected with CT (US). CT (US) had a sensitivity of 86% (82%) and a specificity of 98% (98%) in the diagnosis of choledocholithiasis. CONCLUSION: Both unenhanced spiral CT and US are useful for evaluating suspected common bile duct stones. US is recommended because of its wider availability and lower costs. Unenhanced spiral CT is indicated when the patient is likely to have ampullary stones.

1420
Dual phase liver CT — does liver attenuation vary with the direction of table movement?
E O'Riordan, C Craven, D Wilson and P J Robinson
Department of Clinical Radiology, St James's University Trust Hospital, Leeds LS9 7TF, UK
PURPOSE: To measure liver attenuation during arterial and portal phases of liver CT carried out with craniocaudal and caudocranial incrementation. METHOD: In 10 of 20 patients undergoing dual phase helical CT during staging for colorectal cancer, both phases were obtained with craniocaudal incrementation and in 10 other cases the caudocranial direction was used. Attenuation values in the aorta and in peripheral and central liver ROIs were measured on each slice. Central and peripheral liver attenuation was also measured in 10 patients undergoing unenhanced CT. Slices were numbered in time order of acquisition. RESULTS: Both peripheral and central ROIs showed progressively increasing attenuation during the arterial phase, irrespective of the direction of scanning. During the portal phase, liver attenuation was stable with craniocaudal acquisition, but decreased with caudocranial acquisition. Aortic attenuation was stable during the arterial phase in both directions, but in the portal phase it decreased during caudocranial acquisition. Central liver attenuation was lower than peripheral in unenhanced livers and during both phases of caudocranial acquisition. Central liver attenuation was also lower than peripheral during the portal phase of craniocaudal acquisition, but there was no significant difference during the arterial phase. CONCLUSION: The direction of acquisition does not influence sequential liver enhancement during the arterial phase. Craniocaudal acquisition produces more stable enhancement during the portal phase. Differences in attenuation between central and peripheral areas of the liver are probably unrelated to contrast administration.

1430
CT arterioportography high flow multiphasic helical CT in the detection of focal liver lesions
T Riepl, D H Szolar, A Ruppert-Kohlmayr, R Stacher and K Preidler
Department of Radiology, Karl-Franzens-University Hospital, Auenbruggerplatz 9, A-8036 Graz, Austria
PURPOSE: To compare the relative diagnostic value of biphasic helical CT arterioportography (CTAP) *vs* high flow multiphasic helical CT (HCT) in the detection of focal liver neoplasms.

MATERIALS AND METHODS: In 26 patients with suspected primary or secondary hepatic neoplasms, multiphasic HCT and biphasic CTAP of the abdomen was performed. Two blinded radiologists retrospectively evaluated multiphasic HCT scans and biphasic CTAP scans respectively. Histopathologic evaluation or intraoperative ultrasound was obtained in 16 patients, and results were compared with imaging findings. 10 patients were compared regarding any difference in lesion detection with both modalities. RESULTS: One patient had to be excluded because of abberrant right hepatic artery. In 15 patients with a proved histopathological correlation of 25 lesions, the observers detected 24 lesions at multiphasic HCT (sensitivity 96%) and 24 lesions at biphasic CTAP (sensitivity 96%). In the remaining 10 patients nine identical lesions were detected with both modalities, hence showing no significant difference in lesion detection. Biphasic CTAP showed five false positive lesions (specificity 75%) and multiphasic HCT showed no false positive lesions (specificity 100%). False positive rates were not calculated for the group, which did not have intraoperative ultrasound. CONCLUSION: Helical CTAP does not enable detection of significantly more focal liver neoplasms than does multiphasic HCT. High flow multiphasic HCT has significantly higher specificity than helical CTAP.

1440
Discussion

1400–1530
State of the Art Symposium
Paediatric Interventional Radiology
Hall 5

1400
Invited Review
Interventional vascular radiology in children
P John
Radiology Department, The Birmingham Children's Hospital, Birmingham B4 6NH, UK
Paediatric interventional radiology now offers successful treatment options for infants and children with a variety of vascular disorders, *e.g.* (1) 'endangering' haemangiomas and vascular malformations, renovascular hypertension, portal hypertension and certain causes of haemorrhage, (2) central venous access problems, maintenance of haemodialysis access and (3) compromised graft vascularity following liver and renal transplantation. The purpose of this paper is to illustrate the range of contemporary vascular interventional procedures (excluding cardiac and neurovascular) available for children, illustrating how these can be performed using balloon angioplasty, embolization, sclerotherapy, stents and filters, central venous line placements and thrombolysis. Paediatric vascular intervention differs from adult practice because of specific age related pathology and technical modifications required to carry out these procedures. Arterial access via a small femoral artery may be difficult (spasm and trauma easily occurs). Arterial thrombosis can be minimized with systemic heparinization, using small vascular sheaths, perfusing sheaths with heparinized flush and utilizing correct catheter sizes. Lack of patient co-operation necessitates general anaesthesia. It is essential to monitor volumes of administered fluids including contrast and to minimize body heat loss. Vital signs and peripheral pulses should be observed after the procedure and adequate analgesia given. Steroid cover may be required in treating vascular malformations. In order to achieve success in treating paediatric vascular disorders the radiologist should have a good understanding of the pathology of the lesions, have experience in paediatric vascular techniques and be prepared to work as part of a team.

1440
Invited Review
Aspects of presentation and management of childhood neurovascular disease
W J Taylor
The National Hospital for Neurology/Great Ormond Street Hospital, Queen Square, London WC1N 3BG, UK
It is commonly assumed that cerebral arteriovenous malformations are congenital in nature, and that their impact on the brain is static and rigid. From our experience in adults and children, it seems more plausible that the development of vascular malformations is a failure of normal remodelling processes and the effects of this are recognized as a spectrum of symptoms that depend to some extent on the maturation of the vascular system through childhood. The results of GOSH experience with childhood vascular malformations will be presented, the majority of which are of the Galenic type. The methods of selection, timing and outcomes will be discussed, with emphasis on the need for a multidisciplinary approach for the best outcome for the child. Childhood intracranial aneurysms are a much rarer condition than in the adult population and capacity for spontaneous thrombosis and repair is recognized, although therapeutic intervention is sometimes required.

1505
Invited Review
Biopsies in children — radiologist or surgeon?
J M Somers
Radiology Department, Nottingham City Hospital NHS Trust, Nottingham NG5 1PB, UK
Radiologically guided biopsy is widely accepted as a tried and tested technique for obtaining diagnostic tissue from a wide range of anatomic sites. In children there are still considerable differences in practice and opinion as to whether surgical or radiological biopsy is most appropriate. In childhood malignancy there are particular considerations that do not pertain in adults: (1) Malignancies in childhood are different to those in adults. (2) Malignancies in childhood arise from primitive cell types. (3) Prognosis is dependent upon tumour biology as well as stage of disease. (4) Full pathological assessment requires biopsy specimens suitable for chromosomal and other specialist pathological techniques. (5) Children usually require general anaesthesia for biopsy and central line placement and sometimes CT/MRI. Careful co-ordination is required to minimize the number of anaesthetic episodes. In this talk I will address the opposing views under the headings: Is it safe? Is it effective? Is it appropriate? Is it practical? The ultimate decision as to the most appropriate method of biopsy in children will depend upon local circumstances, expertise and resources, and needs to be taken in conjunction with paediatric surgeons, oncologists and pathologists.

1400–1545
State of the Art Symposium
Radiotherapy of Breast Cancer: Technical Developments 1
Hall 11A

1400
Invited Review
Quality assurance in breast radiotherapy: a multicentre programme
E A Winfield, A Deighton, K Venables, E Aird, P J Hoskin and J R Yarnold, on behalf of the START Trial Committee
Mount Vernon Hospital Cancer Centre, Northwood, Middlesex HA6 2RN, UK
A quality assurance programme is an integral component of the START trial, a multicentre trial comparing different post-operative radiotherapy schedules for early breast cancer. This is important to confirm reproducibility and accuracy within a centre to ensure clinical observations reflect true differences in the randomized schedules rather than variations in radiotherapy technique and protocol. In view of the variations in technique and spectrum of fractionation schedules used in post-operative breast radiotherapy, the decision was made to implement an initial survey by postal questionnaire. This was designed to cover specific areas of patient immobilization, fractionation and technique for tangential, nodal and boost radiotherapy. Patient outlines were provided for dose distribution to be produced according to each centre's routine protocol. The purpose is to evaluate routine breast radiotherapy techniques and identify potential discrepancies prior to focusing on centre visits. A copy was sent to 33 centres that had expressed an interest in the trial, and 28 completed questionnaires were returned. Significant variations in technique are evident throughout the entire treatment process from planning to implementation of treatment. Differences highlighted, which will be discussed, include immobilization, technique for tangential fields, nodal treatment, field arrangement and prescription points, the use of asymmetric collimators and energy

selection. The effects of variation in planning techniques in terms of inhomogeneity correction, dose distribution and acceptable dose variations have also been studied.

1430
Invited Review
The clinical need for 3D planning in breast cancer
J R Yarnold
Academic Radiotherapy Unit, The Royal Marsden NHS Trust, Sutton, Surrey SM2 5PT, UK
The clinical need for 3D compensation of radiotherapy to the breast after tumour excision is not established, although the expectation is that there are worthwhile benefits to be gained. Retrospective studies suggest that patients with larger than average breast size are more likely to have major dose inhomogeneities above and below the central plane of tangential fields, even if lung corrections are applied. Differences in the volume of breast tissue at, above and below the central plane of tangential fields are obvious sources of dose inhomogeneities, which can be in 20% higher than the reference isodose. It is difficult to prejudge the impact of partial volumes raised to high doses per fraction. The pilot study of the START Trial demonstrates a twofold difference in the probability of change and breast induration between 13 fractions of 3.0 and 13 fractions of 3.3 Gy. In this experimental context, a 10% difference in dose per fraction translates into a highly significant difference in clinical outcome. The hypothesis that differences in dose per fraction to portions of the breast arising from suboptimal dosimetry are of clinical significance is currently being tested in a prospective randomized trial comparing patients planned on a transverse contour through the central axis of tangential fields with patients planned using transmitted dose information gathered by megavoltage imaging. The standard treatment is implemented by standard tissue compensators ("wedges"), and the experimental treatment by latter custom-made physical compensators.

1450
Invited Review
Physical aspects of breast radiotherapy
[1]P M Evans, [1]E Donovan, [1]C Hector, [1]M Partridge, [1]J R N Symonds-Tayler, [1]S Webb and [2]J R Yarnold
[1]*Joint Physics Department and* [2]*Department of Radiotherapy, Institute of Cancer Research and Royal Marsden NHS Trust, Downs Road, Sutton, Surrey SM2 5PT, UK*
The potentially important gains of external beam radiotherapy to the breast are generally offset by the use of techniques that predispose to deaths from ischaemic heart disease and non-fatal complications such as arm lymphoedema, brachial plexopathy, breast pain, poor cosmesis and pneumonitis. One of the main contributing factors to these complications is believed to the delivery of inhomogenous dose distributions. Dose non-uniformity in breast radiotherapy often exceeds the figure of 10% normally considered to be acceptable. Factors contributing to this are: the presence of inhomogeneities such as lung; variations in the distance between beam entry and beam exit points; and variations in the source to skin distance. Methods have been developed to use compensators and/or multileaf collimators to delivery intensity modulated beams in order to improve the dose inhomogeneity, particularly in the case of tangential irradiation. MLCs may also be used to shape the fields to shield critical structures such as the anterior wall of the left ventricle of the heart in the case of left-sided patients. The discussion will focus on the use of methods of improving dose inhomogeneity in tangential irradiation. A novel method of using electronic portal imaging to design compensators will be presented. This method is currently being evaluated in a randomized trial. Preliminary dose volume data from this trial will be discussed. An important consideration in the use of compensators is the consequences of patient movement. This issue will also be addressed.

1510
Invited Review
Indications and techniques for nodal irradiation in breast cancer
A Fourquet, F Campana, R Dendale, A de la Rochefordière and J R Vilcoq
Department of Radiation Oncology, Institut Curie, Paris, France
The long term results of several randomized trials conducted after 1980 showed that adjuvant radiotherapy to the chest wall and regional nodes may prevent distant metastases and increase survival in patients at risk, even when adjuvant, medical treatment is given. However, none of these trials determined whether this benefit was specifically related to the regional nodal irradiation in patients with breast cancer. Retrospective studies showed conflicting results, mainly owing to selection biases. The EORTC radiotherapy and breast co-operative groups have started a prospective randomized trial to evaluate the benefit of internal mammary and supraclavicular nodal irradiation in patients either with involved axillary nodes or with centrally or medially located breast cancer without axillary involvement. This trial started in 1996, and plans to include 4000 women with stages I-III invasive breast cancer. Following either mastectomy or breast-conserving surgery, with axillary node dissection, half the patients will receive internal mammary and supraclavicular nodal irradiation to 50 Gy in 25 fractions, and half will not have nodal irradiation. Breast irradiation is delivered to all patients with breast-conserving surgery. Chest wall irradiation can be delivered irrespectively of nodal irradiation. Older trials did not show a benefit of radiotherapy, because patients who received post-mastectomy irradiation had an increased cardiac mortality, related to cardiac irradiation. Nodal irradiation techniques may vary from one centre to another, regarding the beam arrangements, energies and doses. Modern radiotherapy tools help to target treatment volumes and reduce toxicity. Since inappropriate treatment technique may obviate the expected long-term benefit from regional irradiation, it is important that these tools are used in all radiotherapy centres. A quality assurance study is being conducted in parallel to the EORTC trial, aiming at homogenizing treatment techniques between centres and at providing references for the routine breast cancer irradiation.

1530
Discussion

1400–1500
Scientific Session
Paediatric Radiation Protection
Hall 11B

1400
A study of the application of paediatric radiology reference levels
A Montgomery and C J Martin
Clinical Physics, Western Infirmary, Glasgow G12 8SQ, UK
Radiation exposure of paediatrics is of particular concern because of the greater health detriment. Therefore it is particularly important to ensure that radiation doses for paediatric radiology are kept to a minimum. In this study the application of patient dose reference levels similar to those used for adults has been investigated. A study of the relationship between entrance surface dose and patient age and size has been made in three hospitals. The data have been used to derive conversion factors to describe relationships between doses for children of different ages. Paediatric dose surveys have divided paediatrics into five age groups and a CEC document has set initial reference levels for a standard 5 year old patient. The aim of the study has been to determine ways in which dose estimates for paediatrics of all ages can be related to the CEC or other reference levels. The usefulness of equivalent patient diameter (EPD), weight and age as variables relating to doses has been examined. Simple conversion factors in look-up tables, with age as the variable, have been derived that link doses for patients of a variety of ages for particular examinations. It is proposed that factors of this type could be applied in order to identify departments where doses are higher so that changes could be made to radiographic practice.

1410
A multicentre analysis of variations in dose to children undergoing micturating cystograms
[1]A Rogers, [1]S Goodliffe, [1]M Holloway, [2]C-L Chapple, [3]J McKinstry, [4]M Scriven, [5]E Hunter, [6]M Purdue and [7]K Shakepeare
[1]*Medical Physics and* [7]*Radiology Departments, Nottingham City Hospital,* [2]*Regional Medical Physics Department, Newcastle General Hospital,* [3]*Radiology Department, Royal Belfast Hospital for Sick Children,* [4]*Paediatric Unit, Clinical Radiology, Southampton General Hospital,* [5]*Radiology Department, Queen Victoria Hospital, Newcastle,* [6]*Paediatric Radiology Department, Queen's Medical Centre, Nottingham, UK*
Studies of doses received by adult patients undergoing radiological examinations are subject to wide variations, both within and outwith centres. The same is true for paediatric patients and recent publications have highlighted these differences. However, there is

little information in the published press on the causes of these dose variations apart from some analysis of the effect played by different equipment. This study was designed to allow the effect of more clinical parameters such as pathology, outcome etc. to be estimated. It presents an analysis of dose variations in paediatric patients undergoing micturating cystograms in terms of equipment factors, patient related factors, technique related factors and other factors such as referral patterns. It also attempts to chart a path towards the goal of setting paediatric reference doses. The conclusions are that non-equipment related factors can play the dominant role in determining dose variations and that the setting of paediatric reference doses should take these factors into account.

1420

Assessment of the effect of additional copper filtration on paediatric dose rates and image quality

[1]E M Pitcher, [2]D J Grier, [1]R Holmes, [1]K L Smart and [2]F Swanborough

Departments of [1]Medical Physics and Bioengineering and [2]Radiology, United Bristol Healthcare Trust, Bristol BS1 6SY, UK

Paediatric patients are considered to have a higher risk from radiation than adults and therefore there is a particular need to reduce patient dose as much as is possible without significantly impairing image quality. Doses can be reduced by the addition of thin copper filters and a study was set up using an existing Siemens fluoroscopy unit used solely for paediatric examinations. The aim was to evaluate experimentally and clinically the optimum thickness of copper filter to be added and to measure the actual dose reduction obtained when this filter was added permanently to the unit. The effect of adding a range of copper filters (from 0.1 to 0.5 mm) on patient dose and image quality was assessed using 10 cm or 15 cm of Perspex to simulate a paediatric patient. The image quality was assessed using Leeds test objects. The selected filters were then assessed clinically by the paediatric radiologists over a range of examinations and patient sizes and 0.1mm Cu was selected to give the optimum result. A summary of this work will be presented. A dose area product meter had been fitted to the fluoroscopy unit and patient measurements were being collected. A total of 800 dose area product measurements were collected before the copper filter was added and a further 1500 to date. The results of this survey will be presented with the data analysed both by type of examination and patient age and weight. An estimate of the reduction in the risk of fatal cancer induction will be given.

1430

Paediatric pelvic imaging — optimization of dose and radiographic technique using digital fluoroscopy

[1]R Waugh, [2]H M McCallum, [1]M McCarty and [3]R J Montgomery

[1]Radiology Department, [2]Regional Medical Physics Department and [3]Department of Trauma and Orthopaedics, South Tees Acute Hospitals NHS Trust, Middlesborough TS4 3BW, UK

PURPOSE: Children with developmental hip-dysplasia and Perthes' disease can attend for several pelvic X-ray examinations during the course of their disease. Dose minimization is desirable in children as they are particularly susceptible to the effects of radiation. Installation of new fluoroscopy equipment allowed us to explore a new modality for imaging the paediatric pelvis, enabling us to optimize all aspects of the examination: technical, practical and dose reduction. METHOD: Entrance surface dose was assessed for a conventional X-ray technique using a grid and a fluoroscopic technique of pulsed fluoroscopy and one digital image. Dose was assessed using anthropomorphic paediatric phantoms and measured patient doses. A gonadal protection audit was carried out for both the conventional and fluoroscopic techniques. RESULTS: It was demonstrated that the fluoroscopic technique reduced the entrance surface dose by around a factor of 5 when compared with the conventional gridded radiographic technique. The fluoroscopic technique was also found to have technical and practical advantages: it was quicker, easier, it provided more accurate first-time placement of gonad shielding, tighter collimation of the final image and better adherence to paediatric pelvic imaging guidelines. CONCLUSION: These findings resulted in several changes in practice: selected paediatric cases were imaged using fluoroscopy and new improved gonad shields were designed. When a new general X-ray room was installed and a direct non-gridded conventional technique was advocated, patient doses were again compared with fluoroscopy. Further dose reduction options are planned for the fluoroscopic technique and these results will also be presented.

1440

Radiation dose reduction in paediatric cranial CT

C Y Chan, Y C Wong, L F Chau, S K Yu and P C Lau

Diagnostic Radiology Department, Tuen Mun Hospital, Tsing Chung Koon Road, Tuen Mun, Hong Kong

Cranial CT in children is a common diagnostic procedure. But there has been no consensus about the optimal tube current settings (measured in milliampere-second, mAs). As a result, the difference in radiation dose among centres using the same model of CT scanners is large. The effects of such variations are more pronounced in children as they are more vulnerable than adults to radiation damage. In our study, we have explored the optimal mAs setting that gives minimal radiation without compromising the diagnostic accuracy in cranial CT in children. A prospective trial was performed. 53 consecutive children (aged 1 to 12) underwent CT at 200–250 mAs, which was the manufacturer's recommended setting (control group). Another 47 children underwent CT at 125–150 mAs (study group), which was based on the results from an earlier phantom study. The images were evaluated by two radiologists who were blinded to our study. Image quality and the degree of confidence in making a diagnosis were graded on a 4-point scoring scale of 1 (poor) to 4 (excellent). Reliability tests were also performed to assess intrareader agreement. Results showed that image quality in both groups was good and comparable. Statistical analysis showed no difference in the degree of confidence in reaching a diagnosis between both groups in both readers ($P=0.13$ & 0.70) with good intrareader agreement. Thus a substantial dose reduction ($\sim$60%) can be achieved in CT brain examination in children without jeopardizing the diagnostic accuracy.

1450

An objective way to standardize the mAs for CT of the paediatric brain

T H Wong, W T Lai and S K Yu

Department of Diagnostic Radiology and Nuclear Medicine, Tuen Mun Hospital, Tsing Chung Koon Road, Tuen Mun, Hong Kong

Although CT is a commonly used advanced imaging modality, the determination of the radiographic technique for CT of the paediatric brain is a subjective decision. For standard head examinations most of the factors such as applied voltage are very consistent, while the selection of milliampere seconds (mAs) varies significantly even for the same make and model of CT system (by a factor of 3–4 in the UK). Consequently images may contain an unacceptable noise level or the patient may receive excessive radiation. The purpose of this study was to develop an objective method for the determination of an appropriate value of mAs for CT of the paediatric brain. To determine the distribution and variation in head size for paediatrics, image data from 164 studies were obtained, the max AP diameter were determined and the thickness of the skull bone was measured at the mid-brain level. The water equivalent of the AP diameters was then calculated. To assess the image noise level, various sizes of water phantoms were scanned with a Picker PQ6000 scanner (Picker International, Highland Heights, Ohio), with settings according to the manufacturer's recommendation except for the mAs. It was observed that the image noise increases linearly with the AP diameter. Assuming the manufacturer's recommended mAs values are optimal for the average AP diameters, the corresponding image noise levels that are considered "acceptable" can be calculated. The relationship between the mAs and the measured AP diameters is formulated by fitting a second order polynomial equation. Therefore the "appropriate" mAs setting can be estimated objectively.

1500–1600
State of the Art Symposium
The Future of Musculoskeletal Imaging
Hall 6

1500

Invited Review

Osteoporosis — the silent epidemic. Let's shout about it in the Millennium

S Barlow

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The diagnosis of osteoporosis is simple. The prediction of who may have propensity towards it and the challenge to prevent its onset

are far more complicated. This review seeks to provide an overview of the methods of diagnosis and treatment available in 1998. It will include details of the manifestations of the disease and its implications to both the quality of life of the sufferers and the cost to the NHS. The evaluation of the methods of diagnosis will be outlined comparing DEXA, pDEXA, QUS, QCT, pQCT and morphometry, showing how each modality has a different area of expertise. There will be an attempt to explain the way different anatomical sites are measured and how each site's results can be used in diagnosis. The paper will then go on to suggest how the method of diagnosis may evolve over the next 5–10 years, taking into account the wealth of expertise available in the world of osteoporosis screening coupled with a little "crystal ball gazing"! The possibilities are many and varied and will probably include MRI in some form. Whatever happens, the profile of osteoporosis and its management will be higher in the Millennium.

1525
Invited Review
Radiographers reporting on ankle trauma
K L Wainford
Department of Diagnostic Radiology, The General Infirmary at Leeds, Leeds LS1 3EX, UK
There has been debate concerning the role of the radiographer, in radiographic reporting, since Swinburne's comments in 1971 that radiographers could be trained in pattern recognition. This talk will briefly describe how one group of radiographers came to be issuing immediate radiograph reports (hot reporting) on accident and emergency musculoskeletal trauma. However, the main component of the talk will concern a practical review of ankle trauma. Ankle injuries account for approximately 10% of accident and emergency X-ray referrals with up to 20% of these demonstrating a fracture. Ankle joint stability relies on the co-operate work of bones and ligaments working together. Bone damage can often be readily demonstrated radiographically whereas ligament injury has to be inferred from bone displacement, or incongruence of the ankle mortise. Hence injuries may present with a wide variety of patterns — some subtle, some not. Being able to assess the mechanism of injury can assist one in a search for more subtle injuries. Fractures of the ankle joint are rarely due to just inversion or eversion forces, more commonly they result from a combination of forces. Factors that determine the injury are: position of the foot/ankle at time of injury, the direction of the applied force and the resistance of the inherent joint. Being familiar with some of the terminology and classifications orthopaedic surgeons sometimes use in the description of ankle trauma may assist us as radiographers in the understanding of ankle trauma.

1550
Discussion

1500–1700
Scientific Session
The Future for the Barium Enema, *in association with the Special Interest Group in Barium Enema*
Hall 8

1500
Invited Review
Colorectal cancer screening: a role for the barium enema
S N Glick
Radiological Sciences Department, MCP — Hahnemann University, Broad and Vine Streets, Philadelphia, Pennsylvania 19102, USA
Colorectal cancer is the second leading cause of cancer death in the United States. There has been evidence for some time that detection of this disease at an early pathologic stage improves 5 year survival. In recent years, studies have supported the hypothesis that the investigation of asymptomatic average risk individuals (*i.e.* screening) can result in a reduction in disease specific mortality. However, it remains unclear as to how the population should be screened. Proposed modalities such as faecal occult blood testing, flexible sigmoidoscopy, colonoscopy and barium have differential attributes with regard to accuracy, cost, and risk to the patient. Thus, expert guidelines panels have come to realise that each strategy has the potential to be effective and the selection of an approach should be dependent on one's prioritization of the respective test characteristics and resource availability. The presence of multiple options should theoretically enhance overall participation in a colorectal cancer screening program. The primary advantage of the barium enema is that it examines the entire colon, can detect significant adenomas and carcinomas with high accuracy, and is safer and less expensive then colonoscopy. A detailed analysis of the relative merits and deficiencies of the various screening procedures is essential to determining an informed decision. Unfortunately, the barium enema is frequently ignored in discussions or reviews concerning colorectal cancer screening. Reasons may include economic or self-referral agendas, skewed informational exposure, perceptions concerning test accuracy, and lack of perspective concerning all of the issues. Through clarification and objective interpretation of the literature the value of the barium enema can be appreciated.

1530
Does digital imaging reduce barium enema radiation dose?
E O'Riordan, M R Wiggins and A H Chapman
Radiology Department, St James's University Hospital, Beckett Street, Leeds LS9 7TF, UK
PURPOSE: To assess if digital barium enema radiology results in a significant reduction in radiation dose. METHOD: Four types of barium enema examination were performed using a digital fluoroscopy room with a tilting table and a conventional overcouch tube. The fluoroscopy unit could provide a non-digital examination (5 overcouch and 5 undercouch radiographs), a partly digital examination (5 digital films, 5 radiographs) and a digital examination (10 digital films — 2 groups using different field sizes). 25 patients matched for gender and age were included in each group. Patients with pathology were excluded. To standardize the study all examinations were performed by one radiologist. Patient thickness was similar in all 4 groups. RESULTS: There was no significant difference in the dose area products between the groups. There was a significant difference in the screening time with a mean screening time of 3.5 min in the non-digital group compared with 5.4 and 5.5 min in the digital groups. Had the digital studies involved the shorter 3.5 min screening time a significant reduction in radiation dose would have been achieved. CONCLUSION: Radiologists performing digital barium enema examinations without the advantages of an overcouch tube need to pay particular attention to screening times if the reduced radiation benefits of using digital equipment are to be achieved as extra screening time is involved in obtaining adequate double contrast images.

1540
Double contrast barium enema sensitivity: a comparison of radiographer and radiologist performed studies
D G Culpan, A J Mitchell and A H Chapman
Radiology Department, St. James's University Hospital, Beckett Street, Leeds LS9 7TF, UK
PURPOSE: A retrospective study of histologically proven cases of colorectal cancer (CRC) was performed to assess whether the sensitivity of radiographer performed double contrast barium enema (DCBE) differed from that of radiologist performed studies. MATERIALS/METHODS: Histologically proven cases of CRC from 1995 to 1998 were reviewed to ascertain if the diagnosis had been made by DCBE, whether the lesion had been correctly diagnosed and whether the examination had been performed by a radiologist or radiographer. RESULTS: In the 3 year period there were a total of 479 cases with histologically proven CRC. 240/479 (50.1%) had undergone DCBE as first line radiological investigation. There were 64 examinations performed by radiographers. A correct diagnosis was made in 58 (90.6%), an equivocal report in 1 (1.6%), false negative in 4 (6.25%), and 1 (1.6%) case was abandoned. There were 176 examinations performed by radiologists. A correct diagnosis was made in 157 (89.2%), the report was equivocal in 1 (0.6%), false negative in 17 (9.6%), and 1 (0.6%) case was abandoned. CONCLUSION: A sensitivity of 90.6% for radiographer performed studies compared favourably with 89.2% for radiologist performed studies and supports the practice of radiographers performing

barium enemas. These sensitivities also compare favourably with those of the recent Indiana (83%) and Wessex (85%) surveys.

1550

Radiographer performed barium enemas — an audit of a training programme in a district general hospital

F A Hawke

Radiology Department, Borders General Hospital, Melrose, Roxburghshire TD9 6HQ, UK

PURPOSE: To determine the effectiveness of an in-house training programme and the performance of the radiographers who participated in the training. METHOD: The team of four radiographers was audited after the "supervised" portion of the programme and again after the "unsupervised" portion of the programme. An individual performance review and formal practical assessment were carried out between the two sections of the audit. The service, provided by the radiographers, will be continuously audited. This will be done by regular individual performance reviews. The audit parameters were screening time, dose, examination parameters, pathology pick-up rate, radiological input, and interpersonal skills. 50 examinations were audited per radiographer in both the supervised and the unsupervised section of the training programme. The appropriate sections of the audit sheet were completed by the radiographer and radiologist. The data were then recorded and manipulated using Excel. RESULTS. 96% of examinations performed by radiographers were considered adequate, with over 70% considered either good or excellent. The screening time clustered around 3–4 min. The dose range was approx. 2000–4000 cGy cm^2. The pathology pick-up rate for the radiographers ranged from 64% to 82% rising as the training progressed, the miss rate falling from 20% to 5%. Interpersonal skills and radiologist input were charted. CONCLUSION. The team of radiographers succeeded in demonstrating a standard acceptable to the consultant radiologists. The service was acceptable to the Trust and the programme of continuous monitoring ensures that the high standard is maintained.

1600

What features at barium enema are useful predictors of a benign or malignant sigmoid stricture?

A Blakeborough, G Culpan, S E Swift, M B Sheridan and A H Chapman

Radiology Department, Royal Hallamshire Hospital, Sheffield S10 2JF, UK

PURPOSE: To determine the interobserver variation and the discriminatory value of each of 13 observations to assess benign or malignant sigmoid strictures seen at barium enema examinations. MATERIALS/METHODS: The barium enema examinations of 78 patients with a confirmed sigmoid stricture (35 malignant, 43 benign) were randomly sorted and reviewed independently by four blinded radiologists without any clinical details. All malignant strictures had been confirmed histologically. Benign strictures had been established from either histology or clinical follow-up of at least 6 months. Each radiologist was asked to record the following observations for each case: sigmoid diverticula — present/absent; mucosa at the stricture - destroyed/intact; proximal stricture margin tapered/shouldered; fistula or extravasation — present/absent; shape of stricture — symmetric/eccentric; and length of stricture - <5, 5–10, or >10 cm. RESULTS: By consensus of at least three observers, 22 strictures had mucosal destruction (21 malignant) and 20 strictures had a shouldered margin (19 malignant). Other observations reached higher consensus rates but were less discriminatory. CONCLUSION: Mucosal destruction and a shouldered margin strongly suggest a malignant stricture, but these features are not always present. A diagnosis of benign stricture should be made with caution on radiological appearances alone.

1610

Caecal visualization at barium enema examination

N Dugar, M C Collins and A Blakeborough

Radiology Department, Royal Hallamshire Hospital, Sheffield S10 2JF, UK

AIM: To determine the success rate, and reasons for failure, for complete examination of the colon with a barium enema examination by assessing visualization of the caecum. METHOD: A prospective study was undertaken of all barium enema examinations performed during a 5 month period. A questionnaire identified the operator (radiographer or grade of radiologist) and patient details for each case. All examinations were reviewed by a consultant radiologist, and an assessment of caecal visualization recorded. Of 779 consecutive examinations, 5 were excluded owing to previous right colonic resections (no caecum). RESULTS: The caecum was visualized in 746 of 774 cases (96.4%). Reasons for failure were distal obstructing lesion (8), incontinence (8), faecal loading (5), underdistension (3), poor coating (2), tortuous bowel (1) and patient intolerance (1). Failure rates were significantly higher in patients >75 years of age (12/195 (6.2%) *vs* 16/579 (2.3%), $p<0.03$), but were not significantly related to patient gender, operator type (radiographer *vs* radiologist) or operator experience (grade of radiologist). CONCLUSION: The caecum is reached in the vast majority of patients referred for barium enema examination.

1620

Barium enema in the over 80s — why bother?

M L Abbotson, A Blakeborough and M C Collins

Radiology Department, Royal Hallamshire Hospital, Sheffield S10 2JF, UK

PURPOSE: To evaluate whether a barium enema examination is a worthwhile diagnostic procedure in patients over 80 years old. MATERIALS/METHODS: A prospective study was undertaken of 100 consecutive patients over 80 years old, referred for barium enema examination. For each case clinical details were recorded, as well as a subjective assessment by the examining radiologist of the patient's general condition and mobility, and any problems encountered during the procedure. Assessment of diagnostic quality was recorded independently by consensus of two consultant radiologists. RESULTS: 79 of the 100 studies (80 F, 20 M) were performed on an in-patient basis, with 82 patients regarded as being of reasonable/good condition of general health but with 31 noted to have poor mobility. A diagnostic study was achieved in 78 patients 74 complete visualization to caecum and 4 with a proximal obstructing cancer (all confirmed surgically). In a further 9 patients although the caecum was reached, the diagnostic quality was limited/poor. The remaining 13 examinations were incomplete and/or abandoned with little or no diagnostic value. CONCLUSION: Despite the limitations of elderly patients a barium enema is a worthwhile procedure to consider, as a diagnostic study can be achieved in the majority of these patients.

1630

CT for colonic symptoms: an alternative to barium enema

P Robinson, H Burnett and D A Nicholson

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162 elderly patients underwent CT of the abdomen and pelvis instead of barium enema for a variety of colonic symptoms; these included change of bowel habit, pain, bleeding, anaemia and weight loss. Following standard oral contrast 10 mm contiguous sections were performed from diaphragms to symphysis pubis. Scans were performed unsupervised and reported at a later date by a consultant GI radiologist. Patients were followed up for between 6 months and 4 years. 162 patients have been assessed to date. A further 60 patients have been evaluated and will be included in the final paper. Patients were aged from 54 to 93 years old. Of the 162 cases colonic masses were identified in 9 cases (6 proved to be colonic cancer, 1 diverticular mass, 1 lymphoma and 1 lipoma). Other significant pathology was seen in a further 10 patients (2 Crohn's disease, 1 liver metastases, 1 carcinoma of the ovary, 1 renal cell carcinoma, 1 gastric leiomyosarcoma, 1 diverticular abscess, 1 lower lobe carcinoma of bronchus, 2 CBD stones causing biliary dilatation). Three false positive scans were seen where there was bowel wall thickening ? mass. Further investigations showed no pathology in these three cases. The remaining scans showed no significant abnormality or diverticular disease only. In the majority of cases the CT influenced further management. On review of notes no significant bowel pathology was seen in the follow-up period. Standard CT is a valuable alternative for investigation of colonic symptoms in an elderly population.

1640

Virtual colonoscopy: early experience with endoluminal CT appearances of colonic disease

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PURPOSE: Virtual colonoscopy (VC) provides a novel method for the endoluminal assessment of colonic disease by facilitating the interactive viewing of the large volume of 2D CT-acquired data. The images are analogous to those of conventional colonoscopy. We present our early experience in the appreciation of known colorectal tumours in 10 patients scanned using this technique, compared against video colonoscopy, barium enema and the resected specimen. METHODS: Ten patients underwent full bowel preparation and colonic insufflation to tolerance following 20 mg buscopan iv. Supine and prone single breath hold acquisitions were made using a PQ 5000 Picker CT scanner at 120 kV, 200 mA were

performed with a collimation of 5 mm, reconstruction interval of 2 mm and a pitch of 1.5. The colon was assessed by volume-rendered endoluminal imaging on the Voxel Q workstation ("Voyager" Software, Picker International). RESULTS: VC permitted accurate lesion identification and characterization by combined assessment with the simultaneous orthogonal 2D-data set in the 10 cases. The complete right hemicolon was visualized by VC in all cases (incomplete conventional colonoscopy in 2/10 cases). The effective dose equivalent for VC was 6.6 mSv. CONCLUSION: Virtual colonoscopy volume-rendered endoluminal images gave an accurate non-invasive demonstration of known colorectal lesions. This imaging tool permits rapid interpretation of a large amount of 2D data. Collapsed segments can be problematic but are only as limiting as "red-out" at colonoscopy. VC has a lower radiation dose than a barium enema and is less invasive than colonoscopy, possibly representing an alternative to both in the investigation of colorectal cancer.

1650
Can CT air contrast enema be used as the primary investigation of frail elderly patients?
D Murray, K R Rosenfeld, R Al Mufti, A A M Lewis and L A Berger
Departments of Radiology and Surgery, Royal Free Hospital, London NW3 2QG, UK
PURPOSE: Rectal air contrast CT is being increasingly used as a diagnostic tool in the evaluation of elderly patients with lower gastrointestinal symptoms as an alternative to barium enema or colonoscopy. We reviewed our experience using air contrast CT as the primary investigation. METHOD: We retrospectively reviewed 109 CT studies using rectal air contrast, which had been performed on patients over 70 years old with lower gastrointestinal symptoms. The findings were correlated with subsequent investigations and surgical findings. Those patients with normal scans were followed up clinically in outpatient clinics or by contacting the GP. Average follow-up was for 17 months. RESULTS: Of the 109 colonic examinations, 34 (31%) were reported as normal, 65 (60%) showed diverticular disease, 9 (8%) demonstrated a colonic malignancy and 1 (1%) showed a benign polyp. 1 sigmoid tumour was missed although was later diagnosed on a repeat air contrast CT study. CONCLUSION: In our experience, air contrast CT is a viable alternative to barium enema and colonoscopy in elderly frail patients. The techniques used and the typical appearances of the common colonic pathologies will be discussed.

1515–1630
Scientific Session
Risk and Optimization in Radiation Protection
Hall 11B

1515
Revisiting the Airburst
S R Roff
Centre for Medical Education, Dundee University Medical School, Dundee DD2 1LR, UK
The official position of the UK Ministry of Defence is that "The background dose received by civilians and members of HM Forces serving at or off Christmas Island in the years 1956 to 1964 was only about 35% of that which they would have received on average had they remained, for that period of their lives, in the United Kingdom — that is, some 100 microsieverts per calendar month less at Christmas Island than in the United Kingdom" (SSI-2 revised 20 November 1987 as SSI Issue 2). In October 1997 the National Academy of Sciences wrote in a report on thyroid cancer induced by nuclear weapons tests at the Nevada Test Site that: "Nuclear tests (also called burst, shots or events) releasing radioactivity into the air are categorized by the position of the detonation point relative to the earth's surface. This categorization arises from the direct and secondary explosion phenomenology as the explosion interacts with its environment. Whether or not the fireball created by the shot touches the ground is the separating criterion between types. The typical air shot, of which the high-altitude shot is a special case, explodes at a height where the fireball is in its entirety above the surface of the earth so there is little or no interaction with the surface." These two statements will be examined in the light of new historiographical resources which are forcing the reinterpretation of an assumption that lies at the heart of all current radiation protection standards.

1525
Ionizing radiation risk assessment in hospitals
K E Goldstone
East Anglian Regional Radiation Protection Service, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK
Formal risk assessments are now a routine part of an effective health and safety culture and are undertaken for a wide variety of activities. It is essential that quantification is introduced into such risk assessments to ensure that high risk activities are identified, action taken and scarce resources used in the most appropriate fashion. This is particularly true for ionizing radiation but especially difficult owing to a frequently irrational attitude to ionizing radiation hazards not only among the general public but also among hospital staff. An apparently inconsistent approach to the same hazard by different radiation protection advisers can undermine staff confidence and lead to a disproportionate amount of work on the part of radiation protection services. By means of specific examples from hospital practice a quantitative approach to risk assessment will be discussed. A systematic approach should enable radiation protection services to use their hard pressed resources more efficiently, advise employers consistently and prevent a wide variability in practice across the country. Moreover such an approach will be invaluable in enabling employers to fulfil their legal requirement for prior risk assessment.

1535
Extremity dose during endoscopic retrograde cholangiopancreatograms
A Walker
North Western Medical Physics, Christie Hospital, Manchester M20 4BX, UK
General concern with regard to staff dose during endoscopic retrograde cholangiopancreatograms (ERCPs) has led to a study of current extremity dose levels, technique and workload within hospitals in the North West. An assessment of the extremity dose received by staff remaining close to the patient during ERCPs has been made in 12 different hospitals (13 different X-ray rooms). At the same time technique and workload records have been kept. ERCPs are routinely undertaken with increasing frequency in most acute hospitals. Within the North West they are usually performed by non-radiology clinicians and nursing staff with the assistance of a radiographer at the control desk of the X-ray unit. The technique necessitates a number of staff (at least one clinician and two nurses) remaining relatively close to the patient during the whole of the procedure, including fluoroscopy and fluorography. It is concluded that the use of an overcouch tube with no extra protective drapes is indicative of the need for routine extremity monitoring (extremity dose predicted to be greater than 1/10 of the relevant dose limit) for a typical workload of 150 cases per year. Use of extra protective devices is indicated for overcouch tube units and would be essential for high workload centres if classification of personnel is to be avoided.

1545
Doses to hospital staff caring for a helpless patient following treatment with ^{131}I
C Greaves, W Tindale, G Hague and S Sherriff
Department of Medical Physics and Clinical Engineering, Northern General Hospital, Sheffield S5 7AU, UK
Nurses caring for a helpless patient prescribed 800 MBq of ^{131}I were concerned about their radiation dose. Using published dose rate measurements following treatment with ^{131}I and times for nursing helpless patients, we estimated a nurse could receive 650 μSv per shift. Working to a dose constraint of 500 μSv, we advised nursing staff of a regime to limit their dose. Thermoluminescent dosimeters were provided. The patient was transferred to intensive care (necessitating constant medical attention). The TLD results ranged from 5 to 250 μSv (median 145). 3 days post ^{131}I administration, the patient died. A post-mortem was required. Dose rates (μSv h^{-1}) measured at 0.01 m from the corpse at the level of the thyroid, chest and bladder and outside the fridge door were: thyroid, 1800; chest, 290; bladder, 73; and fridge, 11. At 1.0 m these dose rates (μSv h^{-1}) were: thyroid, chest and bladder, 26; and fridge, 3. As the activity in the body exceeded 10 MBq (IRR '85 schedule 6), the coroner's officers were advised to wait at least 2 weeks. The post-mortem took the pathologist 45 min during which time he would have received a maximum dose of 401 μSv. Contamination measurements (Bq cm^{-2}) made following the post-mortem were as follows: pathologist's hands, 5; clothes, 0; towels, 1.8; saw, 5: instruments, 0.5; plastic sheet, 0.8; scales, 0.4; and floors/walls, 1.1. These data

indicate that with appropriate radiation protection guidelines staff can be reassured that their doses are very low.

1555
Predictivity and optimization in diagnostic radiology
B M Moores
Integrated Radiological Services Limited, Unit 188, Century Building, Brunswick Business Park, Liverpool L3 4BJ, UK
The role of science in general and medical physics in particular in fulfilling the revised Council Directive 97/43/Euratom is reviewed. In particular the Directive's reference to clinical audit diagnostic reference levels, medical physics expert, optimization and the need for written protocols is discussed. The need to develop a scientific framework for full implementation of the Directive is highlighted, particularly in the field of optimization. One of the prime requirements for adequate fulfilment will be the need to predict the outcome for a radiological examination in terms of both patient dose and image quality with a particular set of technique factors (kV, mAs, screen-film, speed etc.) selected. A multinational research programme undertaken as part of the Commission of European Communities Fourth Framework Research Programme which explores the role of predictivity in optimization is described. The implications arising from this initiative are presented.

1605
IPEM/HSE national survey of the routine performance testing of diagnostic X-ray imaging systems
E M Pitcher and U F Gooding
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Following the recent publication of IPEM Report 77 "Recommended Standards for the Routine Performance Testing of Diagnostic X-Ray Imaging Systems" the IPEM in conjunction with the HSE felt that it was necessary to investigate the implications of this report. The HSE consider this document to be a guide to good practice in the routine testing of X-ray systems and will therefore be using it when carrying out inspections of hospitals. On behalf of the IPEM and HSE, the Department of Medical Physics & Bioengineering at Bristol has carried out a national survey to ascertain the current level of performance testing in the UK. Results from the national survey will be presented including the percentage of hospitals meeting the essential and desirable recommendations for each test and group of tests, histograms of the actual frequency of testing of selected measurements and the dependence of the above on department type and size. The results will be discussed in terms of the appropriateness of the listed tests and the consequences of the failure to meet the recommended standards. The resources, both in staff time and expenditure on equipment, necessary to reach full compliance with the recommended standards will be evaluated.

1615
Common findings in radiation protection audits
J L Lynch, P A Connolly and B M Moores
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In diagnostic radiology, general guidance on good practice in the protection of persons using or being treated with ionizing radiations has been provided through the publication of the "Guidance Notes for the Protection of Persons against Ionising Radiations arising from Medical and Dental Use". These guidance notes include additional information related to (amongst others) regulations 32 and 33 of the Ionising Radiations Regulations 1985 (IRR85). The guidance notes, therefore, are an invaluable aid in the auditing of diagnostic X-ray equipment for the purposes of providing radiation protection advice to hospitals and other medical establishments. More recently the publication of IPEM Report 77 has attempted to establish recommended standards for routine performance testing of diagnostic imaging systems in terms of the frequency of testing and tolerance indicators to be applied to testing various aspects of these systems. This paper presents some common findings uncovered during radiation protection audits performed on diagnostic X-ray equipment over a 5 year period and indicates the frequency with which certain recommendations have been made. The results are presented under the following broad headings: (1) information and labelling; (2) tube output and kV; (3) filtration; (4) fluoroscopic image quality.

1625
Discussion

1600–1700
State of the Art Symposium
Radiotherapy of Breast Cancer: Technical Developments 2
Hall 11A

1600
Invited Review
Adjuvant radiotherapy for breast cancer: late effects/ clinical issues
P A Canney and C Deehan
Beatson Oncology Centre, Western Infirmary, Dumbarton Road, Glasgow G11 6NT, UK
Radiotherapy has become increasingly used as adjuvant treatment for operable breast cancer over recent years. Outwith clinical trials, post-operative radiotherapy is mandatory following conservative surgery for invasive cancer, and the patients who still have mastectomy tend to fall into a worse prognosis group for whom there is increasing evidence that radiotherapy offers not only increased local control but also improved survival. Particularly against the background of more patients with early good prognosis tumours needing radiotherapy as they have had conservative surgery, the major late effects of radiotherapy must be minimized. For these patients even a small risk from treatment may become significant when viewed in relation to their low probability of death from breast cancer. The most serious late toxicity is cardiac mortality. This has now been confirmed by several retrospective studies including population studies, and this risk can be seen persisting for treatments given into the 1980s; that is into an era when megavoltage treatments should have become routine. As the latency period for cardiac mortality is around 10 years, more recent data are confined to clinical trial reports, which represent only a selected sample of the population at risk. Pneumonitis is relatively common, but usually clinically silent, for the follow-up periods that have been studied. It has therefore become imperative to make every effort to reduce the heart and lung doses by applying modern planning methods to breast cancer treatments. Because randomized trials are impossible and the latency period so long, surrogate end-points for these late effects must be used to compare different radiotherapy treatment strategies.

1625
Invited Review
The use of physical and biological dose distributions in breast treatments
[1,2]C Deehan, [2]P A Canney, [3]A T Redpath, [1,4]T E Wheldon and [1,2]M Glegg
[1]*Department of Clinical Physics and Bio-Engineering, Western Infirmary, Glasgow,* [2]*Beatson Oncology Centre, Western Infirmary, Glasgow,* [3]*Oncology Department, Western General Hospital, Edinburgh and* [4]*Radiation Research Department, Glasgow University, Glasgow, UK*
INTRODUCTION: Studies of radiation toxicity in lung and cardiac tissues during irradiation of the breast have been undertaken by a number of groups. These studies require a knowledge of how the absorbed physical dose and biologically effective dose are distributed throughout the entire volume of these organs. This presentation will review current thinking in this area and show how both physical and biological dose distributions can be used in the study of breast treatments. MATERIALS AND METHODS: CT images of patients were acquired prior to undergoing radiotherapy and networked to a planning computer for radiobiological and physical dose volume analysis. RESULTS: Three dimensional physical and biological dose distributions will be presented with normal tissue complication probabilities (NTCP) as well as biologically effective dose volume histograms. Patient positioning will also be discussed and how this can lead to a reduction in cardiac dose. Results will be compared with those of other studies. CONCLUSION: Patient positioning can play a major role in reducing morbidity to tissues and can be more important than the use of sophisticated treatment planning techniques. Consideration of the physical dose distribution alone will not reveal the underlying biological effects.

1650
Discussion

Posters

National Indoor Arena Concourse Area

Audit

POSTER 0101
Bone age estimation radiographs in bone marrow transplantation
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INTRODUCTION: Bone marrow transplantation (BMT) is being utilized to treat an increasing range of conditions in children. In many transplant units, hand and wrist radiographs to assess bone age are performed as part of the baseline investigations prior to BMT. We set out to evaluate this practice in our institution over a 10 year interval (November 1987 to July 1996). MATERIALS AND METHODS: Retrospective review of radiographic reports, the BMT database and clinical notes. RESULTS: 224 patients 16 years old or younger underwent BMT. Prior to transplantation 160 (71.4%) patients had bone age estimation radiographs of which 155 (96.9%) were normal and 5 (3.1%) demonstrated skeletal immaturity. After transplantation the examination was repeated at some stage (average interval 15 months) in 20 patients of which 19 (95%) were normal and 1 (5%) demonstrated skeletal immaturity (this case had normal bone maturation prior to BMT). CONCLUSION: Undertaking bone age estimation radiographs prior to transplantation does not significantly contribute to subsequent management and this practice should be discontinued.

POSTER 0102
Trauma cervical spines: are the films adequate and who is clearing them?
S R Harries, K D Farmer, S Mohammed and W H Smith
Department of Radiology, Royal Cornwall Hospital, Truro, Cornwall TR1 3LJ, UK
OBJECTIVE: Patients admitted following major trauma have a lateral cervical spine as part of the ATLS series. Frequently a swimmers view is needed. The protocol calls for a full series when the patient is stable. Assessment of these X-rays in conjunction with clinical findings can "clear" the cervical spine. We have performed a retrospective study of cervical spine X-rays from the resuscitation room in the accident and emergency department to evaluate the anatomical adequacy of the X-rays, to assess which films had been obtained and to see who is "clearing" them. METHOD: The X-rays of all patients who underwent the ATLS series for trauma, over a 6-month period, were reviewed by two radiologists independently. The notes of those patients deemed to have inadequate X-rays were assessed to see who had "cleared" the cervical spine. RESULTS: 30% of the X-rays failed to show C7/T1, on the lateral or swimmers view. The initial assessing medical officer passed 84% of inadequate films as "normal". The remaining 16% were recorded as inadequate but no further films were obtained. 65% of cervical spine series were incomplete. The initial assessment was made by the casualty SHO 66%, casualty consultant 16% and orthopaedic registrar 16%. DISCUSSION: We believe these findings emphasize the well documented problems in demonstrating the C7/T1 junction. They highlight the fact that these films are initially assessed by relatively junior medical staff and are frequently passed as normal even when they are inadequate. There is a tendency not to obtain a full cervical spine series. We believe there is considerable scope to improve trauma cervical spine films.

POSTER 0103
An audit of an open access ultrasound service for direct referral from general practitioners
T Hayton, D Cope, S Ahmed, H Russell, M P Callaway and H Andrews
Department of Clinical Radiology, Bristol Royal Infirmary, Bristol BS2 8HW, UK
AIM: To audit the open access direct referral service for ultrasound from general practitioners. METHOD: 341 consecutive patients were reviewed. All patients had been referred to the open access ultrasound service directly from their GPs. The primary reasons for referral and the time between referral and examination were noted. The scans are performed by radiographers, who generate a provisional report. A full report is then generated by the radiologist, who has the option to recall the patient, if necessary, or refer for further imaging if required. Any differences between the provisional and full report were also recorded. RESULT: The mean number of patients examined at each open access session was 7, range 3–12. 117 patients were referred for renal tract abnormality. 22% had the scan the same days as the visit to the GP; 38% attended the day after the GP's consultation. Within 4 days of referral, 89% of patients had been examined. A normal scan was reported in 30% of cases. 92% of provisional reports were not altered by the reporting radiologist. The recall rate was 4% and referral for further imaging 4%. CONCLUSION: Open access provides a prompt, accurate method of ultrasound examination for GPs.

POSTER 0104
12 month audit of accident and emergency referrals for urgent CT head scanning
M Davies, L Pearson, G Thompson, M Quyum and A K Banerjee
Radiology Department, Birmingham Heartlands Hospital, West Midlands, UK
PURPOSE: CT head scanning constitutes a large proportion of emergency work in our hospital. The aim of this audit was to assess the adequacy of documented clinical information from A&E. MATERIALS/METHODS: Over a 12 month period the CT reports of all patients referred from A&E for urgent head scans were reviewed retrospectively and compared with details on the A&E card. The agreed local standard was that all A&E cards should document any history of/mechanism of trauma, the presence of neurological signs and symptoms and the suspected diagnosis. RESULTS: A total of 207 head scans were performed of which 80 (39%) were abnormal. 56 (27%) had intracranial haemorrhages. Only 122 (59%) of the A&E cards were traced. Of these the recording of the relevant data was poor regardless of the conditions severity. 53 (43%) suggested a diagnosis which was correct in 9 (7%) cases. CONCLUSION: We concluded that there is inadequate documentation, storage and retrieval of clinical information in A&E. A prospective 6 month re-audit using a separate written protocol for A&E staff has been suggested.

POSTER 0105
MRI of spinal cord compression
D Jeffrey, P Goddard, S Dunne and C Wakeley
Department of Radiology, Bristol Royal Infirmary, Bristol, UK
OBJECTIVE: To investigate the protocols used to image the spinal cord using magnetic resonance in cases of suspected malignant cord compression. METHODS: Questionnaires were sent to every centre in the UK with access to MRI. RESULTS: A wide variety of sequences are used to investigate suspected spinal cord compression. The most common sequences used are T_1 weighted sagittal (85%), T_1 weighted transverse (59%), turbo T_2 weighted sagittal (59%) and STIR (33%). 41% of centres scan the whole spine irrespective of the neurological level clinically indicated. A further 41% of centres sometimes scan only the area clinically indicated and sometimes scan the whole spine. The most common reason given for scanning the whole spine in this group was finding no abnormality in the initial images. 10% of centres scan only the level of the spine at which cord compression is suspected. CONCLUSION: There is considerable variation between protocols used to investigate suspected malignant cord compression. There is no agreed combination of sequences and there is variation even within a particular centre. Although it has been shown that the level of cord compression may be several segments away from the area clinically indicated, 10% of centres only image the region of clinical suspicion and may therefore miss the lesion. Multiple levels of compression would be missed by centres that only scan the whole spine when the initial scans show no pathology. A nationally agreed protocol for MRI of the whole spine in suspected malignant spinal cord compression should be considered.

POSTER 0106
Image guided 18 G automated needle biopsy of 106 thoracic lesions: a review of diagnostic accuracy and pneumothorax rate
J Dyer
Radiology Department, Queen Elizabeth Hospital, Birmingham B15 2TH, UK
We reviewed the diagnostic accuracy and complication rates of transthoracic needle biopsy (TNB) with an automated 18 gauge core biopsy needle and gun, using either fluoroscopic or CT guidance. 106 lesions were biopsied between 1992 and 1998. Hard copy images, imaging reports, pathology reports and clinical notes were reviewed. 10 were pleural, 26 subpleural but did not require transgression of lung, 10 were mediastinal and 60 parenchymal.

Adequate samples for histological diagnosis were obtained in 104/106 (98%) of biopsies. There were 75/85 (88%) true positive core biopsies for malignant lesions and a specific cell type was identified in 70/85 (82%) of cases. Of the 12% non-diagnostic biopsies, 2 were inadequate, 2 were suspicious of malignancy and 6 were "misses" (false negatives). A specific histological diagnosis was obtained in 12/18 (66%) of benign biopsies. There was a 19% rate of pneumothorax, with only 2.4% of these pnemothoraces being radiologically significant. Both were drained. TNB with an automated 18 G core biopsy needle provided a high level of diagnostic accuracy, effectively distinguished cell type malignancy and provided a definite diagnosis in benign disease more frequently than fine needle aspiration (FNA). There is no increased complication rate compared with FNA.

POSTER 0107
Ward staff knowledge of MRI
H Banister and H Dicken
MRI Department, Leicester Royal infirmary, Leicester LE1 5WW, UK
The radiographers in the MRI Unit at the Leicester Royal Infirmary conducted an audit to determine the level of knowledge of the staff requesting and preparing patients for MRI scans. Misconceptions and incorrect information led to anxious and confused patients and inappropriate requests. Questionnaires were distributed to referring wards and relevant medical meetings. Two interesting points were that 64% of respondents thought that claustrophobia was a contraindication and 68% thought that joint replacements were contraindicated. The full results and their implications on the MRI scanning service were discussed. The results showed the necessity for easily accessible and accurate information to be available on the wards for nursing and medical staff. A form of ongoing education programme is also now being considered.

POSTER 0108
A teleradiology service for the rural community: implications for the radiology department
S R Harries, S Mohammed, T J Cayton-Smith, W H Smith and P G Cook
Department of Radiology, Royal Cornwall Hospital, Truro, Cornwall TR1 3LJ, UK
INTRODUCTION: A teleradiology system providing an acute radiology service to four community hospitals has been installed and fully functional for one year. 1236 images have been reported via the system. The digitized images are transmitted to a central monitor for reporting. METHOD: We describe the hardware of the system. We have monitored the response time for each image to be reported, and we have also performed a prospective analysis to compare the increased time to report a teleradiology image compared with the corresponding plain film. RESULTS: The results are displayed graphically. They demonstrate that 80% of images are reported within the hour. The reporting time for each image was in the region of 2–3 times as long as for the radiograph. DISCUSSION: A teleradiology system provides a fast, accurate radiology report for community hospitals. However, the increased workload on the radiology department must be considered. The demand on the department at busy times leads to delays in reporting the images, and the images themselves take significantly longer to assess. We only have experience of one system but would advocate thorough trials before purchase to ensure any system is accurate, fast and "radiologist friendly". We would also suggest thorough organization for reporting rotas and allowances to be made for radiologists' time in any budgets. These issues will become increasingly important with further development of teleradiology.

Breast

POSTER 0501
Fantastic phantoms
N Ridley and S Taylor
Breast Screening Unit, Princess Margaret Hospital, Swindon SN1 4JU, UK
There has been an increase in the use of image guided biopsy techniques, especially core biopsies, in the pre-operative diagnosis of breast disease and avoidance of open surgical biopsy. Accurate localization of small lesions is essential for successful biopsy and aspiration of ultrasound and mammographic abnormalities. We illustrate a variety of phantoms, both commercial and home-made, we use to confirm the accuracy of our breast imaging equipment and to practise biopsy techniques.

POSTER 0502
MRI of silicon breast implants using the Siemens standard loop surface coil
S Boyd and A Melling
MRI Scanner, Department of Radiology, Leicester Royal Infirmary NHS Trust, Leicester LE1 5WW, UK
In the absence of a dedicated breast surface coil where both breasts can be imaged simultaneously using MRI, the Siemens standard loop coil was used to look at each implanted breast individually. With the patient positioned prone, the breast under examination is placed within the circular loop coil and supported in a concave foam pad, in order to maintain the normal shape. MRI was performed on a Siemens Impact 1 tesla unit using turbo inversion recovery sequences with long and short inversion times. The image quality was examined by assessing motion artefact reduction, and overall resolution. Ease of positioning and patient comfort were also investigated. The radiology reports were examined chronologically for 12 implanted patients, eight of whom had subsequently had surgical review. The findings were then compared. False positives were demonstrated together with minor flaws and genuine implant rupture.

Cardiovascular System

POSTER 0601
MRI of the thoracic aorta
A J P Goddard, D J Beacock, U M Sivananthan and W H Smith
Department of Radiology, Leeds General Infirmary, Leeds LS1 3EX, UK
This poster presentation will demonstrate state of the art imaging of pathology of the thoracic aorta and aortic root. The conditions demonstrated will include congenital anomalies (vascular rings, coarctation, pseudocoarctation), Marfan's syndrome and its complications. We will also demonstrate the evolution of aortic aneurysms from atheroma to ulcerated plaque and intramural haemorrhage to dissection. Examples of current endeavours to map normal and abnormal blood flow dynamics, aortic distensibility studies and non-invasive blood flow and pressure measurements will be presented. We will show pathologies of the aortic root and demonstrate how MRI can be used to follow patients post-operatively after aneurysm and coarctation repair. Overall, we will demonstrate that MRI has the ability to be a comprehensive cardiac and aortic imaging tool in the pre-operative and post-operative patient.

POSTER 0602
MRI scanning for suspected coarctation on mobile MRI units in a District General Hospital
W E Rhoden and D Nag
Departments of Radiology and Cardiology, Barnsley District General Hospital NHS Trust, Barnsley S75 2EP, UK
PURPOSE: To assess the feasibility and effectiveness of MRI scanning for suspected coarctation in a District General Hospital (DGH) using 0.5 and 1.0 T mobile MRI scanners. METHOD: Over a 2 year period, 12 patients were scanned, with an age range of 16–66 years. The main indications were hypertension with bruits or an abnormal aortic contour on the chest radiograph. Four patients had a history of coarctation, one repaired in childhood, one managed with balloon dilatation and two untreated. All patients had an axial T_1 SE and an oblique sagittal T_1 SE sequence. Coronal or T_2* GRE sequences were obtained in five patients. 2–4 NEX, FOV 30–40 mm and a matrix of 192 × 256 were used with central cardiac gating and respiratory compensation. No physiological or pressure indices were obtained. RESULTS: The oblique sagittal images were the most useful, angulation varying from 20–37° LAO but optimal planes required repeat scans on five patients. The average scanning time was under 30 min. Severe juxtaductal coarctation with poststenotic dilatation was seen in two, moderate stenosis in one, and only minimal contour irregularity in a further two patients. No collaterals were demonstrable. Seven patients showed a normal arch and upper descending aorta. Good correlation was obtained with echocardigraphy in seven patients, and with IVDSA in three patients. All patients who also had transoesophageal echocardiography preferred MRI. CONCLUSION: MRI on mobile scanners is practical and clinically effective in a DGH setting for the initial diagnosis and follow-up of coarctation.

POSTER 0603

Review of pericardial pathology using MRI

A J P Goddard, D J Beacock, W H Smith, T N Bloomer, J P Ridgeway and U M Sivananthan

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MRI is an invaluable tool in the characterization of pericardial disease as it provides both anatomical and functional information. This pictorial essay demonstrates our experience in imaging a wide variety of pericardial pathologies including constrictive pericarditis ($n=27$), pericardial effusion ($n=32$), with and without tamponade, benign and malignant tumours ($n=6$) and pericardial defects ($n=3$). Our imaging protocol includes multiple axial spin echo imaging, four and two chamber gradient echo imaging and assessment of flow patterns across the atrioventricular valves. We will discuss the relevance of these parameters for each condition. In addition, we will demonstrate the value of follow-up assessment post-operatively where appropriate. The value of functional and anatomical imaging in the differentiation of restrictive cardiomyopathy from constrictive pericarditis will also be demonstrated. We will discuss the use of MRI in relation to CT and echocardiography in the diagnosis of these pathologies.

Chest

POSTER 0701

Aunt Minnie's atlas of high resolution CT of the chest

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Departments of Radiology, [1]Cardiothoracic Centre, Thomas Drive, Liverpool and [2]University Hospital, Aintree, Liverpool, UK

High resolution CT (HRCT) of the chest is a well established technique for the assessment of interstitial and alveolar lung disease. It is our perception that many general radiologists find the interpretation of HRCT a difficult and sometimes daunting task. As well as narrowing the differential diagnosis in complex cases, HRCT can allow a specific diagnosis to be made in a significant number of defined conditions. We present a pictorial atlas of pulmonary pathology that has characteristic and pathognomonic features on HRCT. Recognition of typical appearances will enable a specific diagnosis to be readily made.

POSTER 0702

Haemoptysis of unusual aetiology: imaging and percutaneous management

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PURPOSE: To demonstrate the radiological appearance and interventional management of a series of unusual causes of haemoptysis. METHODS: A series of unusual causes of haemoptysis referred for diagnosis and percutaneous management were collected from two tertiary centres over a period of 10 years. Several unusual causes of haemoptysis will be presented including transdiaphragmatic migration of a foreign object, aneurysm within a pulmonary metastasis, sequestration, pulmonary arteriovenous malformation, haemorrhagic aspergillomas, and others. Their radiological appearances and percutaneous management will be presented in the form of a pictorial essay. CONCLUSION: Inflammatory conditions such as cystic fibrosis, sarcoidosis and infectious aetiologies remain the leading causes of haemoptysis. However, as medical management of these conditions improves, unusual causes represent an increasing proportion of all cases of haemoptysis presenting to the radiologist. Diagnostic angiography of bronchial, pulmonary and systemic arteries as well as CT are the primary radiological tools for evaluation. Percutaneous diagnosis and treatment, when possible, avoids the morbidity and mortality associated with surgery and includes embolization of bronchial, pulmonary and systemic arteries as well as intracavitary placement of antifungal agents. As the natural history of haemoptysis changes, the differential diagnosis must be expanded to include unusual causes such as those presented here.

POSTER 0703

Radiological findings in lymphoproliferative disease following thoracic transplant

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Heart and lung transplant recipients are particularly predisposed to post-transplant lymphoproliferative disease (PTLD). This is a complication of immunosuppression. The presentation of PTLD is protean and presents diagnostic difficulties in patients prone to opportunistic infections and rejection. A delay in diagnosis can cause an increase in morbidity and mortality. Between March 1987 and March 1998, 269 heart, 36 heart/lung, 29 double sequential lung and 66 single lung transplants have been performed at the Wythenshawe Heart & Lung Transplant Centre. To date, 17 patients have been diagnosed as having PTLD in whom the sites of disease have been varied. Of these, 14 occurred in heart, two in heart/lung and one in single lung recipients. This gives an overall incidence of PTLD of 4.3% in all transplant recipients. CT and ultrasound have been successfully used at our institution for the detection and staging of PTLD. We present the radiological findings in these patients.

Education

POSTER 0201

A comparison of computerized log-books with conventional log-books

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This is a study comparing entries documented by specialist radiology registrars in their conventional log-books with a computer assisted record keeping system recently introduced at the Manchester Royal Infirmary. This program has been incorporated into the department's existing computerized system of record keeping. Data comprising entries over a 3 month period were collected from the log-books of specialist registrars in their first 3 years of training, and compared with the computerized entries over a similar time period by an identical number of trainees. This comparison demonstrated that the computerized log-books are a more effective method of maintaining records. The system is user friendly, entries are not mandatory; the system automatically incorporates data to a trainee's record, with provision for entering additional information if required. This allows the trainees to maintain a comprehensive record of their activities, which is also readily available to the College assessors for monitoring the trainees' progress. The records are permanent and may be transferred to a floppy disc. This system also has the added advantage over other computerized systems in that it does not require a separate PC for it to be operational.

POSTER 0202

Radiology education in Albania: challenges associated with assessment of a new curriculum

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Over the last 5–6 years Albania has begun to adopt the European curriculum for radiology education, including for pre- and post-graduation training. Radiology accounts for less than 1% of the healthcare budget in Albania and less than 0.01% of the medical education budget is devoted to pre- and post-graduate training in radiology. The total length of medical education is 280 weeks, only 60 hours of which are devoted to radiology. In our University, radiology education takes the form of lectures (15 h) and practical training (45 h). The general curriculum of pre-graduation education in diagnostic radiology comprises three sections: (a) a basic course in radiology anatomy and functional imaging; (b) an introductory course in clinical radiology; and (c) a general course in imaging and interventional radiology. After 6 years of studying at medical university, a student works for another 4 years to obtain a specialist degree in radiology. The student must spend these four years of training at the University hospital, not in the radiology department of a municipal hospital. It is obligatory to spend 2 years working on conventional X-rays, 8 months on ultrasound, 2 months on paediatric radiology, 5 months on CT and 5 months on interventional radiology and angiography. Organizing post-graduate training is mainly the job of the Albanian Association of Radiology. We have good relations with Italian, Greek and Hungarian societies although our contact with colleagues in Central and East European nations are not as strong because these countries have problems similar to ours. To date, Albanian radiologists have not profited from the Haley Project or other teaching programmes devised by the European Association of Radiology. One of our biggest problems is a lack of specialist books and foreign periodicals. Our department relies on free subscription from the major radiology journals such as *Radiology*, *Radiography*, *American Journal of Radiology* and *Journal of Vascular and Interventional Radiology*.

POSTER 0203

The OSCE in radiography: a decade of experience

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The Objective Structured Clinical Examination (OSCE) was originally developed by Ronald Harden and was first reported in the *British Medical Journal* in 1975. It was used for the assessment of medical students but today its application has spread into other associated professions including radiography. South Bank University first used OSCE in 1989 as part of the final year assessment of the BSc (Hons) Radiography, the examination being undertaken in the education centre. On revalidation of the course in 1993 it was decided that the OSCE would more appropriately be located in the clinical department. The rationale for this change of venue will be presented. When the course was revalidated again in 1997 a decision was taken to utilize an OSCE for each of the 3 years of the course as a summative assessment. The current OSCE examines differing aspects of competence, including pattern recognition, patient positioning and patient management. Each aspect of competence is examined at several stations thus it is possible to assemble a profile of each student. This profile can then be used to identify areas of strength and weakness in order to promote remedial teaching in subsequent years of the course. CONCLUSION: Experience has shown the OSCE to be a valuable tool in the assessment of academic and clinical skills and South Bank University is continuing to develop its use.

POSTER 0204

Puzzled about continuing professional development?

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Since the introduction of the concept of Continuing Professional Development (CPD) in 1993, CPD has been met with a mixed response by radiographers and PAMs in general. Feelings range from a positive reception to confusion to open hostility. The overriding impression given was that many radiographers did not understand the process of CPD and what is expected of them. As student radiographers beginning our careers we objectively approached the task of creating a poster by employing simple research methodologies, as a learning process, to allow a thorough appreciation of the process of CPD and the expectations of the radiographer to ensure professional standards are maintained during the process of lifelong learning. The aim of producing the poster was to promote CPD positively and actively in the work place. This involves explaining the concept as a whole; outlining the expectations of the professional and also the radiographer's expectations of the employer; and explaining who benefits in the department. The poster highlights the main issues in point form and pictorially. A handout of further information and useful addresses will be available.

POSTER 0205

Multimedia radiological database with Internet access distributed on AIX and NT operating systems

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PURPOSE: A multimedia database is used in radiological clinics to store and retrieve patient data and images (conventional radiology images, ultrasound images, MR and CT images etc.). MATERIALS AND METHODS: The hardware we are using consists of several Pentium IBM PCs using an OS Windows NT 4.0, and a RISC station IBM RS 6000 with an OS AIX 4.3. Considering the hardware available, we decided to use a DBMS DB2 5.0 supplied by IBM in interaction with a DBMS Microsoft SQL Server 6.5. RESULTS: The multimedia database may be accessed by every department in the clinic. The access programs are written in a variety of programming languages such Visual Basic 5.0, Lotus Approach and Access on Windows NT Stations. The radiological images are stored in a high resolution format of 1024 × 1024 pixels. The medical data and radiological images may be published on the Internet and accessed from other clinics. CONCLUSION: The system is used to store data and images for all patients and assists clinicians from different departments in the diagnostic process. The multimedia database also can be utilized for educational purposes.

POSTER 0206

Design and implementation of an angiographic teaching system

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PURPOSE: The goal of the system is to offer medical students the opportunity to learn the basics of angiography and to offer the teacher the opportunity to verify the students' knowledge by means of a multimedia interventional radiology teaching system. METHODS AND MATERIALS: The hardware consists of a Pentium PC with an OS Windows NT. The software is generated using Multimedia Toolbook and Delphi. The rules are created by experienced radiologists. Digital images and films in AVI format are downloaded online through an Ethernet LAN from the angiograph, CT, Doppler, MRI or ultrasound device. Images are acquired through a video digitizing board. RESULTS: The system is offered on CD. The program may be accessed by a LAN. The student has all the information he needs: digital images taken from the Doppler system, short films and a set of correct and wrong answers, all of them included in a friendly interface. CONCLUSION: The system is utilized in the Radiological Clinic in Cluj. It offers a multimedia environment for students studying medicine, in particular interventional radiology. In addition, the information system is an expandable one, and may be extended with new images, films and rules.

Gastrointestinal

POSTER 0901

An holistic picture of the barium enema examination

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PURPOSE: To obtain an holistic picture of the extent of patient feeling regarding the barium enema examination. MATERIALS AND METHODS: Preliminary work was used as a situational analysis as it uncovered the aspects of the examination that were important to the patients, the meaning of these and the effect they had on the patients. From the data collected an interview guide was developed which covered the specific areas of questioning. A series of focused interviews was carried out with people who had experienced a barium enema. Respondents were questioned in an attempt to elicit information that tested the developing hypotheses. This method allowed for specific information to be gathered whilst allowing the patients' subjective experiences of having a barium enema to emerge. RESULTS: The data from this study have established patients' feelings about and experiences of the barium enema examination from the appointment through the examination to their return home. Each area highlighted by the respondents will be addressed separately and depicted in table form. CONCLUSION: This study has enabled an holistic picture of the barium enema to be drawn from the patient's perspective and supplied data for studies into patient care issues surrounding one of the most personally invasive diagnostic examinations. Several areas have been highlighted for further investigation, such as aftercare and fear of cancer. This will be addressed in further work.

POSTER 0902

The effect of timing of buscopan injection on the quality of double contrast barium enema

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AIM: To determine whether the timing of buscopan administration during double contrast barium enema examination affects the quality of the study. METHOD: In a prospective study, 45 consecutive patients undergoing outpatient double contrast barium enema examinations were given 20 mg buscopan (Hycoscine-N-butylbromide, Boehringer Ingelheim Ltd, Bracknell, UK) intravenously either prior to infusion of barium (Group A), or after barium infusion and air insufflation (Group B). Barium coating as an indicator of diagnostic quality and visualization of colonic segments were assessed by subjective and objective analysis. The screening time for the procedure and whether difficulty in infusion of barium was experienced were also recorded. RESULTS: 27 patients (60%) were randomized to Group A and 18 (40%) to Group B. The mean age was 58 years (range 23–97). 25 patients were female and 20 male. There was no significant difference in colonic coating between the two groups ($p=0.96$, Mann–Whitney U test), nor in visualization of colonic segments ($p=0.96$, Mann–Whitney U test). Difficulty in infusion of barium was experienced in 6/27 (22%) patients in Group A compared with 8/18 (44%) in Group B. The mean screening time for Group A was 2.64 min compared with 2.77 min in Group B which was not significant. CONCLUSION: The timing of buscopan administration during double contrast barium enema has no significant effect on the quality of the study or the screening time for the examination. A greater degree of difficulty was experienced with infusion of barium when buscopan was injected after barium and air administration.

POSTER 0903
Charlatans in the caecum: pitfalls in barium enema diagnosis
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A Charlatan is an impostor — usually in the medical field. Here we present briefly a series of three separate cases of benign lesions masquerading as malignant tumours in the caecum. In each case the patient had a barium enema performed which showed what appeared to be a carcinoma of the caecum. In all cases the patients subsequently underwent laparotomy and colonic resection for what turned out to be benign disease. The first case is that of idiopathic caecal ulceration. The imaging features and management options of this rare condition are discussed. The second case is that of a large ulcerated lipoma of the caecum which was undergoing intermittent intussusception. The final case is that of an unusual presentation of Crohn's disease which caused a pseudotumour appearance in the caecum on barium enema. The possibility of benign conditions mimicking malignancy in the caecum should be borne in mind thus minimizing the risks of unnecessary surgery.

POSTER 0904
The CT appearances of caecal volvulus
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Caecal volvulus is uncommon and is the cause of intestinal obstruction in only 1–3% patients. Diagnosis is not difficult if the classical textbook plain radiographic findings are present in a patient with appropriate clinical signs and symptoms. Occasionally, the clinical scenario is misleading and other methods of investigation such as ultrasound or CT are performed initially. The purpose of this poster is to present three such cases of caecal volvulus, each of whom underwent CT prior to plain abdominal radiographs. Learning objectives: (1) to describe the CT features of caecal volvulus; (2) to identify underlying aetiological factors; (3) to emphasize the primacy of the plain abdominal radiograph in the radiological investigation of caecal volvulus.

POSTER 0905
Right-sided diaphragmatic hernia with malrotation
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PURPOSE: To report the varied appearances and document the incidence of malrotation in neonates with right-sided congenital diaphragmatic hernia (CDH) treated at Great Ormond Street Hospital for Sick Children. MATERIALS AND METHODS: The radiographs of 16 non-consecutive patients with proven (rt) CDH were reviewed. All the cases presented with respiratory distress in the immediate newborn period. There were nine males and six females. Chest and abdominal radiographs were performed in all cases. RESULTS: Emergency surgical correction was required in all patients and six examples (37%) of malrotation were detected peroperatively. The size of each diaphragmatic hernias was described as moderate to large and each was located posteriorly or posterolaterally. The contents of the hernia included liver, small or large bowel. No hernia included the stomach. The malrotation was always associated with Ladds bands but no volvulus occurred. In one patient a Meckel's diverticulum was detected. CONCLUSION: The varied imaging findings of neonatal right CDH are presented. A 37% associated frequency of malrotation was documented. This is a higher incidence of malrotation than is generally recognized. Malrotation should be sought peroperatively (and also in follow-up barium studies) in all children with right CDH.

POSTER 0906
A pictorial review of carcinoid tumours
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Carcinoid tumours arise from neuroendocrine cells. There are multiple sites in the body in which the primary may occur. The site of origin influences the appearances and characteristics of the tumour. The majority of carcinoid tumours arise in the appendix (45%) and the small bowel (25%); however, they also arise from other areas of the gastrointestinal tract, the bronchus, thymus and ovary. This poster will illustrate the appearance of carcinoid tumours both of the more well known sites and also of some of the more unusual sites. Examples of several imaging modalities will be used, including plain films, CT, MRI and nuclear medicine imaging.

POSTER 0907
A pictorial review of the MRI appearances of perianal sepsis
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PURPOSE: For many years, examination under anaesthetic (EUA) by an experienced surgeon has been the "gold standard" in the preoperative assessment of perianal sepsis. Recent studies, however, have shown that MRI examination can be as good as, and in some cases better than, clinical assessment, particularly in the demonstration of complex fistulae and supralevator sepsis. This poster presents a pictorial review of the MRI appearances of perianal sepsis and the classification of perianal fistulae. METHODS: The MRI examinations performed at our unit between May 1996 and October 1998 on all patients suspected of having perianal sepsis were assessed retrospectively, and all the current literature was reviewed. RESULTS: 36 of 60 patients presenting with suspected perianal sepsis proved to have positive scans. Parks' classification (Br J Surg, 1976) was used to assess the images and a representative selection of different fistula types was obtained for this pictorial review. CONCLUSION: Advances in MRI techniques have led to the development of MRI as a valuable tool in the pre-operative assessment of perianal sepsis, to rival EUA.

POSTER 0908
Investigation by MRI of suspected perianal fistulation: spectrum of alternative diagnoses
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PURPOSE: MRI has been shown to correlate well with surgery in defining the surgical anatomy of perianal fistulae and their complications, and allows prediction of long-term outcome. Any imaging test must also allow confident diagnosis of alternative pathologies which may mimic the condition being investigated. In this teaching poster we describe the MRI features of a range of conditions which affect the perineum. METHODS: All patients were examined with T_2 weighted axial and dynamic contrast enhanced axial and coronal MRI with a body coil at 1 T to an identical protocol. All diagnoses were confirmed by surgical follow-up at a minimum of 12 months. Cases are drawn from a 5 year study of more than 250 cases in a specialist unit. RESULTS: A variety of perianal, cutaneous and superficial gynaecological conditions are illustrated and discriminant features described to allow distinction from perianal fistulation. CONCLUSION: MRI allows accurate diagnosis of a wide range perineal diseases.

POSTER 0909
Helical CT diagnosis of superior mesenteric venous thrombosis
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Superior mesenteric venous thrombosis (SMV) is not unusual but it is rarely suspected clinically. The diagnosis has often been made at surgery or autopsy. With the development of new imaging techniques, various forms of this condition have been recognized. We present four patients in whom helical CT demonstrates the typical features of SMV thrombosis. CT is also useful in demonstrating in cross-section both the bowel wall thickness and symmetry as well as the changes in the mesentery, when there is associated ischaemia. Two patients presented with acute abdomen with dilated loops of small bowel on plain abdominal film, and CT demonstrated SMV thrombosis with thickened segment of small bowel and proximal dilation. One patient was managed conservatively, the other underwent resection of the ischaemic segment. In the third patient SMV thrombosis was an incidental finding on CT performed for postoperative pyrexia. The fourth patient with chronic renal failure and sclerosing peritonitis as a complication of chronic ambulatory peritoneal dialysis (CAPD) was scanned following abnormal ultrasonography for abdominal pain. CT showed SMV thrombosis as well as gas within the SMV without any evidence of bowel wall necrosis. The third and fourth patients were managed conservatively. The risk factors in these patients will also be discussed. In all four patients the SMV thrombosis was unsuspected and helical CT demonstrated the thrombosis and the associated findings accurately and guided further management.

Genitourinary

POSTER 1001

Spiral CT angiography of potential kidney donors

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CT angiography (CTA) is an established non-invasive technique that was made possible by the development of spiral CT. The use of CTA in investigating potential kidney donors is increasingly recognized as an alternative method to the combined use of conventional angiography and excretory urography. Volume data are acquired during maximum vascular contrast enhancement and the scans are reconstructed using a two-dimensional multiplanar reformatting (MPR), and three-dimensional maximum intensity projection (MIP) techniques. Accurate assessment of the number of renal arteries and level of arterial bifurcation depends on adequate vascular enhancement and careful review of the axial and MPR images. The scanning protocol and the usefulness of the post-processing techniques are presented. We also present examples of the common pitfalls of the examination and correlate the imaging with the surgical findings.

POSTER 1002

The assessment of acute pyelonephritis with ultrasound

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PURPOSE: The diagnosis of acute pyelonephritis (APN) is based mainly on the clinical and bacteriological findings. Radiology is useful in ruling out obstructive causes that often require surgical management. Our study has analysed the role of renal ultrasound (US) in patients with clinical symptoms, signs and history compatible with APN and who have normal plain abdominal X-rays. MATERIALS AND METHODS: We examined 240 patients with renal US referred from the Emergency Department with symptoms and signs suggesting an APN (fever, flank pain and irritative voiding symptoms). Patients who have complained of renal colic and those with a previous history of urological disease other than uncomplicated recurrent urinary tract infection were excluded. Patients who were diagnosed with plain abdominal radiography to have kidney lithiasis were excluded. Renal US evaluation was also carried out by another ultrasound specialist to rule out hydronephrosis. RESULTS: 98 (40.8%) of the 240 patients had an abnormal US scan. These patients were evaluated again by US or intravenous pyelography (IVP) or both. Obstructive uropathy was demonstrated in only 16 cases (6.7%). All these patients were treated successfully by surgery. CONCLUSIONS: Renal US evaluation indicated surgical treatment in a minority of our patients (6.7%) with clinical features of APN and plain abdominal radiography with no evidence of lithiasis. This incidence is likely to be lower in the outpatient setting. It may be more reasonable to perform US and IVP in those patients, with suspected APN, who do not have a completed response to the initial antibiotic therapy.

POSTER 1003

MR urography: a potential screening tool?

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Magnetic resonance urography (MRU) has shown potential as a non-invasive technique in examination of the urinary tract. Patients who have had urinary tract reconstructive surgery, in the form of ileal conduit formation, require regular examination of their renal tract for complications. This is normally by ultrasound, IVU and conduitograms. Two main groups are identified, those who have undergone a pelvic exenteration for pelvic organ malignancy and those who have undergone cystectomy for bladder malignancy. The former are at risk of progressive dilatation of the upper renal tract and ensuing renal failure and the latter are at increased risk of tumour recurrence in the renal tract. We describe four patients with ileal conduits who have undergone MRU utilizing a fast half fourier sequence (single shot fast spin echo, SSFSE). Two patients had undergone anterior exenteration for cervical carcinoma and two patients had had cystectomies for transitional cell carcinomas of the bladder. We demonstrate their MRU findings and compare them with other imaging techniques and surgical findings. As this technique does not involve ionizing radiation or contrast media, and has the further advantage of a short examination time, it could be considered as a potential screening tool for patients with ileal conduits.

POSTER 1004

Correlation of cross-sectional imaging and surgicopathological findings in children with Wilms' tumour

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PURPOSE: To correlate cross-sectional imaging (CT and MRI) with surgicopathological findings in children with Wilms' tumour, prior to chemotherapy. METHOD: 20 of 108 children met the strict entry criteria for inclusion, namely a histological diagnosis of Wilms' tumour and imaging prior to both surgery and chemotherapy. Following blinded analysis by two paediatric radiologists, findings were correlated with surgical and pathological reports, with respect to tumour size, capsule breach, inferior vena cava (IVC) invasion and lymph node identification. RESULTS: The Bland and Altman 95% limit of agreement for tumour size was (−)126 cm^3 to (+)178 cm^3 (mean difference (d) 25.95 cm^3). The IVC was correctly identified as being tumour free in 18 children. Sensitivity of detection of capsule breach was 33% (specificity 64%). Sensitivity of hilar lymph node detection was 32% (specificity 50%). At the paraaortic region it was 69% (specificity 57%). Some small nodes contained tumour (<5 mm), and some larger nodes (=2.0 cm) were tumour free. CONCLUSION: There was a wide limit of agreement in the difference between the estimated tumour volumes. Perirenal tissue invasion remains a histopathological diagnosis. Detection of renal hilar lymph nodes is difficult because of close association with the tumour mass and paucity of surrounding intraabdominal fat. Paraaortic nodes were more easily seen than renal hilar nodes. At both sites, nodal size is unrelated to tumour infiltration, as very small nodes (<5 mm) contained tumour.

POSTER 1005

Ultrasound findings in closed scrotal trauma

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PURPOSE: To revise the wide range of ultrasound signs observed in closed scrotal trauma based on our own experience. MATERIAL AND METHODS: A search was conducted to select the ultrasound examinations (grey scale and Doppler) performed at our institution between March 1995 and August 1998 because of closed scrotal trauma. The ultrasound appearances of the testis and the scrotal layers, as well as the testicular Doppler signals, were recorded. The final diagnosis was confirmed either by surgery or clinical/ultrasound follow-up. RESULTS: 13 patients were selected (12–83 years old, mean age 33.5 years) with a total of 19 lesions (sometimes a combination of lesions was present). The lesions were classified as: (a) scrotal lesions (scrotal haematoma 4, haematocele 5); (b) spermatic cord lesions (spermatic cord torsion 1, spermatic cord haematoma 1); (c) epididymal lesions (epididymal avulsion 1, epididymal haematoma 1); (d) testicular lesions (intratesticular haematoma 3, testicular dislocation 1, testicular rupture 2). CONCLUSION: The advantages ultrasound offers over clinical examination in the setting of closed scrotal trauma are well known. Ultrasound can prevent emergency surgery if there is no testicular rupture, a testicular haematoma affecting more than 1/3 of the testicular volume or a spermatic cord torsion (diseases confidently diagnosed with ultrasound). The primary goal of our work is to revise the wide spectrum of appearances encountered during the ultrasound evaluation of closed scrotal trauma, in our opinion a topic not completely covered in many radiology textbooks and papers.

POSTER 1006

Paracetamol as a prophylactic analgesic for hysterosalpingography: a randomized double blind controlled trial

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AIM: To evaluate the effectiveness of paracetamol as a prophylactic analgesic for hysterosalpingography. DESIGN: A prospective double blind randomized controlled trial comparing 1 g of paracetamol (SmithKline Beecham, Brentford, UK) to placebo taken 30 min prior to hysterosalpingography. 100 consecutive outpatients were studied prospectively. The analgesic effectiveness during the procedure and at 24 h and 1 week post-procedure was analysed by a postal pain score questionnaire. Additional data on the ethnicity of

the patient, the sex of the radiologist performing the hysterosalpingogram, the parity of the patient, the ease of the procedure and whether pathology was identified were also recorded. RESULTS: 88 patients (88%) replied, 39 (44%) received paracetamol and 49 (56%) placebo. No significant difference was found between women who were pain free in the paracetamol and placebo groups whether during the procedure ($p=0.11$), at 24 h ($p=0.33$, χ^2 test). No significant difference in mean pain scores was determined during the procedure ($p=0.91$), or at 24 h post-procedure ($p=0.94$). Similarly, no difference in mean pain scores was identified with regard to the ethnicity of the patient, the sex of the radiologist performing the procedure or whether pathology was present or not. CONCLUSION: Paracetamol is not effective as a prophylactic analgesic for hysterosalpinography.

Head & Neck

POSTER 0401
Understanding the dental panoramic tomograph

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The dental panoramic tomograph has become an invaluable aid in dentomaxillofacial radiography. This is because it enables the visualization of many structures in a two-dimensional form. The theory of dental panoramic tomography is complex. However, an understanding of how the resultant radiographic image is produced and which structures are in fact being imaged is necessary for a critical evaluation and for the interpretation of this type of radiograph. Many structures can be seen on a dental panoramic tomograph, approximately 20 should be assessed by the radiographer performing the examination. A knowledge of facial anatomy and dental pathology is therefore essential. Different dental tomography machines require slight adjustments in patient positioning prior to exposure. The radiographer should be aware of which external facial landmarks form the radiographic baseline that is to be employed. As with all radiographic procedures, the radiographer must be able to correct faults which occur during the examination and this will lead to a better understanding of how the dental rotational tomogram is produced.

POSTER 0402
MRI of the normal teeth and dental apices

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MRI has not been previously used for the assessment of teeth and the dentoalveolar region. A normal volunteer with no dental restoration and no previous extractions was studied using a Siemens 0.2 T Open MRI Scanner. MRI scans were performed using a circular polarized receiver head coil. Scans were undertaken in the transverse, coronal and oblique sagittal planes using T_1 weighted spin echo, short tau inversion recovery (STIR) and fast low angle shot 3D (FLASH) sequences. The scans were performed with the patient's careful cooperation as follows. (1) The subject's mouth was kept closed and the subject refrained from swallowing during scanning. (2) The subject kept the cheeks and lips blown out. (3) The subject held a bolus of water in his mouth. The first, and simplest, method was found to be the best technique for demonstrating the crowns of the teeth. All three methods showed the dentoalveolar area equally well. Blowing the cheeks out with air and filling the mouth with water made assessment of the lips and cheeks easier. MRI of the teeth reveals surprisingly good detail for the assessment of the position and morphology of the teeth. The dental roots were very well shown. The pulp chambers of the teeth were superbly demonstrated with high signal on STIR and moderate signal on T_1 weighting. The neurovascular connections between the teeth and the inferior dental canal were well demonstrated. Eruption cysts were shown around the unerupted wisdom teeth.

POSTER 0403
MRI of the dental apices: periapical pathology

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The teeth and the dentoalveolar area are visible on all MRI scans of the lower one-third of the head but are usually ignored by radiologists and clinicians. There has been a paucity of literature studying dental pathology using MRI. Publications on the use of MRI in dentistry have included work on the temporomandibular joint, assessment of nasopharyngeal tumours and assessment of mandibular and maxillary bone prior to dental implantation but there are, to date, no publications on the MRI of the dentoalveolar region. Using a Siemens Open 0.2 T MRI scanner, a series of six patients with suspected peri-apical pathology was studied. MRI was found to be highly sensitive in the detection of abnormalities around the roots of the teeth. Areas considered to be pathological on X-rays were shown to have high signal on the STIR sequence but a more varied signal on T_1 and T_2 weighting. The extent of the abnormality was exceedingly well demonstrated but the exact nature of the lesion was not always apparent. All patients underwent a minimum of 6 months dental treatment and/or follow-up after the MRI scan. MRI of the dental apices may prove to be of value when planning treatment in patients with otherwise occult or poorly understood dental pathology.

POSTER 0404
Dental materials causing artefacts on MRI sequences

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A variety of dental materials is used in the conservation and restoration of teeth. In order to determine the extent to which different materials caused artefacts, nine different examples of dental materials were individually inserted into fresh apples. The apples were placed in a plastic bowl, secured to the base of the bowl by Blu-Tack and the bowl was filled with oil to a level above the insertion points of the materials. The oil was permitted to seep into any air filled space and the bowl of apples was then scanned in a Siemens 0.2 T Open MRI machine. The apples were scanned using T_1 weighted and T_2 weighted spin echo sequences, short tau inversion recovery (STIR) and a T_1 weighted gradient echo sequence (FLASH). The materials studied included a fractured bur made of tungsten carbide on steel shaft, a Thermafil root filling composed of plastic shaft coated with gutta percha, a silver point root filling, a lump of Permite amalgam, a Charlton post, a lump of Surefil set composite filling material, some Apexit calcium hydroxide root canal cement, half a porcelain to precious metal bonded crown and a half cast gold crown. The greatest artefacts were obtained from the fractured bur and Charlton post and least from the calcium hydroxide root canal cement. Artefacts from dental restoration in patients were also studied and will be demonstrated.

POSTER 0405
Paranasal sinus bony anatomical variations and sphenoid sinus distances: CT analysis for endoscopic sinus surgery

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PURPOSE: Axial and coronal plane CT scanning has dramatically improved the imaging of paranasal sinus anatomy compared with sinus radiography. Increasingly subtle bony anatomical variations of this region may be detected and measurements of some distances may be performed prior to endoscopic sinus surgery. METHODS AND MATERIALS: 500 high resolution CT (HRCT) scans of paranasal sinuses were reviewed. Two CT scanners and consequently two different CT protocols were used: (1) conventional CT: 2 mm slice thickness, 2 s scan time, direct axial and coronal planes; (2) spiral CT: 2 mm collimation, pitch 1, direct axial plane and reconstructed coronal and sagittal planes. Axial plane: from the hard palate to the roof of the frontal sinus. RESULTS: We detailed the percentage of some anatomical variations: chonca bullosa (34%), dehiscent fovea ethmoidalis (19%), bulla galli (15%), onodi cell (14%), agger nasi cells (12%), pneumatized anterior clinoid process (10%), Haller's cells (9%), dehiscent bulla ethmoidalis (8%), paradoxical middle turbinate (8%), pneumatized lamella verticalis (5%), pneumatized uncinate process (4%), dehiscent carotid artery (>1%), dehiscent optic nerve (>1%). In addition, we performed the measurement of some distances regarding the sphenoid sinus: sphenoid septum-optic nerves; sphenoid septum-carotid arteries; nasal spine-sphenoid ostia (naso-ostial line); angle hard palate-naso-ostial line. CONCLUSIONS: The detection of paranasal sinus bony anatomical variations and the measurement of sphenoid sinus distances from optic nerves and carotid arteries are mandatory to guide the otolaryngologist during endoscopic sinus surgery, thus avoiding more serious surgical complications such as rhinoliquorrea and meningitis, amaurosis and arterial bleeding.

POSTER 0406
Vascular causes of hoarseness: a pictorial display on CT

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In addition to laryngeal tumours and inflammation, hoarseness may be due to any pathology that interferes with normal movement of the vocal cords. The adductor and abductor muscles of the cord

are supplied by the recurrent laryngeal nerves which arise from the vagus nerves as they descend the neck within the carotid sheath. The left recurrent laryngeal nerve descends in the mediastinum, hooks under the aortic arch behind the ligamentum arteriosum and ascends into the neck, between the oesophagus and trachea, to supply the larynx. Space occupying lesions involving the aorto-pulmonary window such as bronchial carcinoma, nodal disease and aneurysms of the aorta and pulmonary artery may compress or invade the left recurrent laryngeal nerve as it turns to ascend into the neck. We describe the imaging features in seven patients with hoarseness secondary to vascular compression of the left recurrent laryngeal nerve in the aortopulmonary window. The underlying cause in five patients was an aneurysm of the aortic arch. One patient had a small saccular aneurysm of the pulmonary trunk and another had ectasia of the aortic arch with subsequent dissection. The imaging findings are described in a further patient with a carotid body tumour compressing the vagus nerve in the neck. We outline an algorithm for imaging hoarse patients in whom direct laryngoscopy confirms vocal cord paralysis in the absence of local laryngeal pathology.

POSTER 0407

Nasal TN/K cell lymphoma: MR and CT imaging

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PURPOSE: To describe the MR and CT features of nasal T/NK cell lymphoma and correlate the findings with the stage of disease. MATERIALS AND METHODS: Six patients with nasal T/NK cell lymphoma underwent imaging using MR (6) and contrast enhanced CT (3). The findings were correlated with the stage of disease. RESULTS: All tumours were of low to intermediate signal intensity on the T_1 and T_2 weighted images. Mild to moderate enhancement was present on CT (3) and MR (6) imaging. Diffuse involvement of the nasal cavity was seen in four patients and bilateral involvement in four patients. Extranasal extension occurred in four patients to involve the nasopharynx (4), oropharynx (1) and paranasal sinuses (2). Tumour necrosis was identified in three patients, with destruction of the nasal septum (3), hard palate (1) and nasal turbinates (3). Tumour volumes ranged from 5 to 50 cm^3 with a mean of 21 cm^3. Regional lymphadenopathy was not seen. Five of the lymphomas were classified as stage I and one as stage IV. Large volume destructive tumours with extranasal extension were found in both stage I and stage IV disease. CONCLUSION: Nasal T/NK cell lymphoma frequently exhibits diffuse invasion of the nasal cavity with necrosis, midline destruction, and extension into the nasopharynx. These features may be seen in both early and late stage disease.

POSTER 0408

Surgical applications of 3D imaging in facial reconstruction

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PURPOSE: 3D images are perceived to be a valuable means of communication between radiologist and clinician, especially when dealing with complex lesions. This poster describes the ways in which 3D image data are integrated into surgical practice at different levels in our research programme. METHODS: 3D surface rendering is carried out using a stand-alone processing unit and inhouse software. Data are obtained from high resolution CT images and surface rendered following size correction. Software allows for excision of unwanted areas and final images are displayed in rotating frame. Process data may also be transferred to a computer-numeric-controlled 5-axis mill, which we use to obtain life-size models and also to create moulds for prosthesis production. RESULTS: We have found clinical value in the use of 3D image data in the following ways: (1) as an aid to diagnostic evaluation; (2) images are displayed by television link in the operating theatre as a guide during surgical procedures; (3) models produced from polyurethane foam are similarly used to aid diagnostic evaluation and surgical planning; (4) models may be used as a template to create prostheses, or to create supports for autologous bone grafts; (5) templates may be created from models to produce moulds for the production of customized prostheses from pressed bone chips. CONCLUSION: 3D images have a wide range of use in reconstructive surgery of the face, with the potential for positive impact on the management of the patient at several levels.

Hepatobiliary

POSTER 0801

CT of vascular diseases of the liver

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CT is the standard imaging technique for assessing vascular lesions of the liver. This poster will illustrate numerous vascular lesions of the liver including congenital anomalies of portal vein, portal vein thrombosis, hepatic infarction, hepatic arterial aneurysm, Budd–Chiari disease, passive hepatic congestion from constrictive pericarditis/right heart failure, portal pyaemia, septic emboli, benign and malignant vascular tumours and peliosis. Where possible specific CT features of the above diseases are demonstrated.

POSTER 0802

Liver lesion characterization with MultiHance: results of dynamic imaging studies

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INTRODUCTION: MultiHance is a novel gadolinium-based contrast agent which behaves as a conventional extracellular fluid (ECF) contrast agent in the first minutes after administration and as a liver-specific agent in a later delayed phase. When coupled with delayed (40–120 min), static imaging, MultiHance has been shown to improve significantly the sensitivity of MRI for liver lesion detection. The present study was designed to show that in terms of liver lesion characterization, MultiHance is as effective as conventional ECF agents when administered as a bolus and coupled with dynamic imaging. MATERIALS AND METHODS: The study was part of a phase III multicentre, multinational, prospective, open-label, within-patient assessment of unenhanced and MultiHance enhanced MRI. Each patient was administered 0.05 mmol kg^{-1} MultiHance as bolus. Images were obtained at 1.5 T before MultiHance administration (T_2 weighted SE and T_1 weighted SE and GE sequences), and at 15–150 s, 4–5 min and 8–10 min after MultiHance administration (T_1 weighted GE sequences). RESULTS: When administered as a bolus and coupled with dynamic imaging, MultiHance produced enhancement patterns characteristic of those produced by conventional ECF contrast agents. Malignant lesions (hepatocellular carcinoma, cholangiocarcinoma and metastases) and benign lesions (haemangioma, focal nodular hyperlasia and adenoma) were each identified and characterized adequately with MultiHance in the first minutes after administration. CONCLUSION: MultiHance is effective not only as a liver-specific agent for focal lesion detection but also as a conventional ECF agent for liver lesion characterization.

POSTER 0803

MultiHance in liver lesion detection: results of delayed imaging studies in 113 patients

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INTRODUCTION: MultiHance is a novel gadolinium-based contrast agent which behaves as a conventional extracellular fluid contrast agent in the first minutes after administration and as a liver-specific agent in a later delayed phase. The present study was performed to assess the efficacy of two dose levels for delayed contrast enhanced MRI of focal liver disease. MATERIALS AND METHODS: MultiHance at 0.05 mmol kg^{-1} (57 patients) and 0.1 mmol kg^{-1} (56 patients) was administered as a single intravenous infusion at 10 ml min^{-1}. Images were acquired pre-contrast and at 40–120 min post-contrast (T_1 weighted SE, T_1 weighted GE and T_2 weighted SE sequences). Gold standard imaging comprised IOUS, CTAP and/or lipiodol-CT. MR images were assessed off-site by three independent reviewers and were evaluated for lesion detection rate and diagnostic accuracy. RESULTS: The administration of either dose facilitated: (1) the detection of a significantly higher number of lesions ($p<0.001$); (2) an increased sensitivity for lesion detection (an overall detection rate of 77% post-MultiHance as

opposed to 57% on unenhanced images alone); (3) a higher concordance with gold standard findings (concordance rates of 41–46% pre-dose and 49–54% post-dose, with the greatest and most clinically significant increase observed for 0.05 mmol kg^{-1} MultiHance: +10% ($p<0.05$)); (4) significantly increased confidence in lesion detection/exclusion ($p<0.001$). Overall, the principal investigators assessed MultiHance to be radiological utility in 67/113 patients (59.3%) and to have affected the overall diagnosis for 28/113 patients (25%). CONCLUSIONS: MultiHance, combined with delayed, static imaging, is an efficacious contrast agent for liver lesion detection. A dose of 0.05 mmol kg^{-1} significantly improves lesion detectability over unenhanced MRI.

POSTER 0804

An illustrative guide to the diagnostic potential of magnetic resonance cholangiopancreatography (MRCP)

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The purpose of this poster presentation is to illustrate the potential clinical applications of a recently introduced technique of magnetic resonance cholangiopancreatography (MRCP). All images were obtained on a Picker Eclipse 1.5 T scanner equipped with 27 mT m^{-1} gradients, with a phased-array body coil for signal detection. MRCP was performed with a heavily T_2 weighted Express (single shot fast spin echo) sequence: TR 8000, effective TE 247, ETL 200. The presentation will include examples of the range of biliary tract and pancreatic pathology including benign and malignant strictures, stone disease and post-operative appearances. Emphasis will also be placed on diagnostic pitfalls and limitations of the technique, with correlation of endoscopic and surgical findings. The advantages and disadvantages of oral contrast agents will also be shown.

POSTER 0805

MRCP revisited

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Magnetic resonance cholangiopancreaticography (MRCP) is a non-invasive method of delineating the biliary and pancreatic ducts. It replaces ERCP and other invasive techniques in several clinical situations. This poster presentation deals with the indications and techniques of MRCP. MRCP findings of biliary and pancreatic duct pathologies such as stone disease, congenital anomalies, post-operative infections and tumours are elucidated. Abnormalities noted in MRCP are, where possible, correlated with surgical or ERCP findings. The radiologist needs to be aware of several pitfalls in interpreting MRCP and these are discussed.

POSTER 0806

Interventional radiology in liver transplantation — a review of local practice

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PURPOSE: We are currently reviewing the role of interventional radiology in the management of post-liver transplant complications. More than 500 liver transplants have been performed since 1992 at our institution. METHODS: To date the radiological records of 90 consecutive patients who underwent liver transplantation between January 1996 and June 1997 have been reviewed. The interim results will be presented. RESULTS: The overall post-transplant complication rate was 29% (26 patients). There were 11 biliary leaks (12%), four biliary strictures (4.5%), four hepatic artery thromboses (4.5%), three hepatic artery stenoses (3.5%), no venous complications, eight significant post-operative intraabdominal collections (9%) and three post-transplant malignancies (3.5%). The treatment and outcome of these complications will be reviewed. CONCLUSION: The post-operative course of liver transplantation is complex. The significant post-transplant complication rate requires a dedicated team, incorporating interventional radiology, to ensure successful outcome.

Musculoskeletal

POSTER 1101

The short tau inversion recovery sequence in acute lateral disc prolapse

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INTRODUCTION: The differentiation of clinically significant acute lateral disc prolapse from structurally identical but clinically non-symptomatic lateral disc prolapse may be difficult. This presentation illustrates the potential value of STIR imaging in this situation. METHODS: Two cases with clinically severe L3 radiculopathy were imaged with standard T_1 and T_2 weighted sequences within 2 months of onset of symptoms. In addition, a STIR sequence in the coronal plane was acquired. In one case, the examination was repeated when the patient had clinically improved. RESULTS: Both cases demonstrate right lateral disc protrusion at L3/4, compressing the L3 nerve root. In each case, STIR images show high signal intensity within the enlarged L3 nerve root/root sleeve. Both cases also demonstrate well demarcated signal hyperintensity within the ipsilateral erector spinae and quadratous lumborum muscles. In Case 1, a structurally identical but clinically asymptomatic left L4/5 lateral disc protrusion is noted, with no associated nerve root or paraspinal muscle signal abnormalities. In Case 2, a repeat MRI after 6 months with significant clinical improvement demonstrates no change in appearance of the L3/4 lateral disc on T_1 weighted images, but reduction in the perineural signal hyperintensity and complete resolution of the paraspinal muscle signal abnormalities on STIR. CONCLUSION: STIR imaging may differentiate acute lateral disc prolapse from structurally similar but asymptomatic lateral prolapse. Acute phase changes seen on STIR resolve with clinical recovery.

POSTER 1102

MR imaging of parosteal osteosarcomas

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PURPOSE: Parosteal osteosarcoma accounts for only 4% of all osteosarcomas. This poster illustrates the appearances on MRI of this low grade sarcoma arising on the surface of bone and its value in surgical staging. MATERIALS AND METHODS: 12 cases of parosteal osteosarcoma were seen in a 6 year period. MRI was performed on a 1.0 T Siemens Impact. The MR scans and other imaging were retrospectively reviewed. RESULTS: The mean age in this series was 33 years, nine of the patients were female and nine of the parosteal osteosarcomas presented in the distal femur, two in the humerus and one in the foot. T_1 weighted images showed the tumour signal to be isointense with muscle with areas of low signal and/or signal void corresponding to the typical mineralization. T_2 weighted and STIR sequences showed areas of high signal representing tumour with foci of low signal or signal void. The higher the ratio of non-mineralized to mineralized tissue the greater the likelihood of dedifferentiation. In six of these cases there was invasion of the medulla. In three cases the tumour involved the adjacent joint. MRI confirmed the presence of tumour in all four cases in which recurrent disease was suspected. CONCLUSION: MRI is ideally suited for the local staging of parosteal osteosarcoma. It readily demonstrates the extent of the tumour, relationship to adjacent structures and integrity of the underlying cortex. It can help to indicate an appropriate biopsy site where dedifferentiation is suspected.

POSTER 1103

MRI of inhomogeneous solitary lipomatous lesions

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INTRODUCTION: Inhomogeneous fat-containing lesions include various benign and malignant tumours as well as tumour-like processes. MATERIALS AND METHODS: We undertook a retrospective study of our experience in MRI of inhomogeneous lipomatous lesions. A pictorial review of the MR features is presented. RESULTS: Of the subtypes of liposarcoma, myxoid liposarcoma is usually markedly inhomogeneous and contains less than 25% fat, whereas well differentiated liposarcoma (atypical lipoma) is typically only mildly inhomogeneous and contains over 75% fat. Liposarcomas tend to have thick enhancing septae or nodules

whereas lipomas have thin septae which display only slight if any enhancement. However, spindle cell and pleomorphic variants of lipoma and hibernoma may contain variable amounts of enhancing non-lipomatous components that may be indistinguishable from atypical lipoma. Similarly, simple lipomas may contain various connective tissue elements including fibrous and myxoid tissue and chondroid or osseous metaplasia. Lesions with specific diagnostic features include parosteal lipoma and lipoma arborescens. Angiolipoma is indistinguishable from intramuscular angioma and both may contain serpentine structures and phleboliths. Lesions such as neural fibrolipoma and elastofibroma tend to arise at specific sites, the former usually in the median nerve and the latter in the thorax. Lipoblastoma usually occurs in the first decade — an uncommon age for liposarcoma. CONCLUSIONS: Although some benign inhomogeneous lipomatous lesions have characteristic MR features, other benign inhomogeneous lipomatous lesions may be indistinguishable from atypical lipoma. Thin septae and slight enhancement of the non-lipomatous components suggest benignity whereas thick enhancing septae or nodules are more suspicious of malignancy.

POSTER 1104

Pelvic insufficiency fractures following radiotherapy for pelvic malignancy

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The differentiation of pelvic insufficiency fractures from metastatic disease following pelvic radiotherapy often requires the use of bone scintigraphy, CT and even, in some cases, bone biopsy. Recent papers indicate a possible role for MRI in difficult cases. We present the typical MR appearances of pelvic insufficiency fractures in three female patients following radiotherapy for pelvic malignancy. Following radiotherapy there is fatty replacement of cellular bone marrow. Insufficiency fractures are characterized on T_1 weighted scans by linear areas of low signal amidst the reduced signal of marrow oedema. Soft tissue swelling is characteristically lacking and there is slow or no progression with serial scans. The MR features of ischiopubic insufficiency fractures have only recently been described. In the aggressive form there is a cleft-like elongated T_2 weighted high signal abnormality between the fracture fragments, which does not enhance with contrast. The incidence of these fractures is related to the total dose (>4000 cGy), number of fields treated per day, use of orthovoltage energy, high daily dose per fraction, radiographic evidence of osteoporosis and tobacco use. In conclusion, we present three patients with pelvic insufficiency fractures in whom the diagnosis was made with MR scanning.

POSTER 1105

Acute calcific trochanteric bursitis: radiological appearances and clinical follow-up

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PURPOSE: This paper describes 20 patients with acute severe unilateral hip pain and who had radiographs diagnostic of acute calcific trochanteric bursitis. The aim of the paper is to promote greater awareness of the radiographic features and generally self-limiting clinical course of this condition. METHOD: All hip radiographs of patients presenting with hip pain over a 4 year period were prospectively inspected for radiological evidence of acute calcific trochanteric bursitis by a consultant radiologist. A review of their clinical follow-up was subsequently obtained by: (i) directly contacting all patients' general practitioners; (ii) sending a postal questionnaire to all the patients; and (iii) reviewing of case notes if available. RESULTS: There were 12 female and eight male patients, with an average age of 46 years (range 31–75). Four patients presenting to the Accident and Emergency Department were initially thought to have hip fractures despite no history of trauma. In all patients characteristic amorphous calcification was seen in the region of the trochanteric bursa. In 12 patients this was superior to the greater trochanter, in six patients it was lateral, and in two patients there was calcification both superiorly and laterally. In a single patient there were associated degenerative changes affecting both hips. 18 patients responded to simple oral analgesia and were completely asymptomatic within 4 weeks. One patient required peritrochanteric injection of corticosteroids with the pain settling in 3 weeks. CONCLUSION: Acute calcific trochanteric bursitis can be diagnosed by the radiographic finding of amorphous peritrochanteric calcification. It is usually a self-limiting condition which should be managed expectantly with more aggressive treatment reserved for those with persistent pain.

POSTER 1106

The role of DXA in imaging paraarticular new bone formation in the hip

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PURPOSE: To evaluate the diagnostic efficacy of dual energy X-ray absorptiometry (DXA) in the imaging of paraarticular new bone formation in hips in patients surviving severe head injury. MATERIALS AND METHODS: 43 hips in 27 adult patients within the first year after severe head injury were studied. All patients were pre-selected from the positive radiographic evaluation for hetertopic ossification of the hip. The same patients were studied with DXA in order to assess the capabilities of this method in imaging the heterotopic ossification of the hip compared with conventional radiographic techniques. RESULTS: Only in advanced cases did DXA produce good quality images of the heterotopic ossification of the hips compared with radiographic evaluation which was positive in all cases. (The evaluation of the quantitative study of heterotopic ossification with the DXA was not performed.) DXA compared with conventional radiography gave the following results: 30 true positives and 13 false negatives (including cases with minute spots of heterotopic ossification.) There were no true negative or false positive results (specificity 100%, sensitivity 69.7%, accuracy 69.7%). CONCLUSION: This method may become an alternative imaging technique for evaluation of heterotopic ossification of the hip in advanced cases, particularly for follow-up imaging, instead of using the conventional radiographic technique. In addition, there is a reduction in the radiation dose to the patient with DXA.

POSTER 1107

"My groin hurts" — sports medicine for the radiologist

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During the summer of 1997 it was felt amongst the male members of our staff that fitness levels were falling and that the morale and well being of the staff was in need of revitalization. As our hospital is in the "Premier City" of football in the UK, five-a-side football, or as it turned out seven-a-side, football was started. During the course of one season, which included Charity events and a National "Doctor" five-a-side competition, significant morbidity was encountered. We report on a series of sports injuries that led to significant personal morbidity (but no staff days lost) and discuss the setting up of work-related sports events and how to practise sports medicine for the radiologist properly and safely.

POSTER 1108

MRI in clinically benign soft tissue masses of the thigh

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PURPOSE: To establish the effectiveness of MRI scanning in accurately diagnosing the aetiology of clinically benign soft tissue masses in the thigh. METHOD: Over a 4 year period, 15 patients who presented with a history of pain and/or swelling in the thigh with clinically suspected benign lesions had an MRI scan. The age at presentation was 10–61 years and the duration of symptoms 2 days to 13 months. 11 patients gave a history of trauma either recently or within the past 20 months. All patients were scanned on 0.5 or 1.0 T mobile scanners and had axial T_1 SE and T_2 SE scans with most having an additional T_2 FSE coronal scan. Gadolinium was used in six patients and a STIR sequence was also used in seven patients. The body coil was used in 10 cases and the phased array coil in five. Mean scanning time was 26 min. RESULTS: Seven patients showed evidence of partial muscle tears in the quadriceps group, one had a complete tear of the adductor longus. Two patients showed long-standing intramuscular haematomata in varying stages of resolution and one had a sub-acute haematoma. Only seven of the 11 patients with post-traumatic sequelae gave a definite history of trauma. One patient had a deep abscess, one a soft tissue sarcoma and two showed intramuscular lipomas. There was complete surgical correlation in all patients who underwent exploration. The T_2 FSE axial was the single most useful sequence, depicting the surrounding reactive oedema best; the STIR sequence was helpful in highlighting subtle semi-acute muscle tears/strains. CONCLUSION: MRI scanning in suspected benign soft tissue masses of the thigh is an effective single investigation, allowing accurate differentiation of aetiology with a high degree of confidence, and enabling precise localization for surgical planning.

POSTER 1109

Can a differential ossification in the medial knee compartment lead to a genu varus deformity?

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Research involving the STR/ORT murine model of osteoarthritis (OA) has shown increased bone formation differentially in the medial subchondral bone compartment as compared with the lateral. Histological evidence has also shown that the growth plate's natural advancement during elongation might be affected by this differential ossification. In some old mice a genu varus deformity (bow legs) has been observed. METHODOLOGY: 20 coronal serial sections of 27 age-ranged knee tibial plateaus from the STR/ORT were stained. The age range was 1–22 months. The tinctorial stain used was a variation on a standard van Geisson. These were viewed under magnifications of ×16 to ×256. RESULTS: The histology observed (upper age range, 9 months and above) showed in some individuals, with almost total subchondral bone ossification in the medial compartment, a linear configuration of the subjacent growth plate. The adjacent lateral compartment growth plate showed an arching effect. CONCLUSIONS: The natural elongation of the tibia will obviously mean a relative advancement of the growth plate during the lifetime of the individual mouse. If the medial compartment is almost entirely filled with compact bone it is postulated that this might cause retardation of growth in the medial compartment. This might eventually create a negative tilting of the tibial plateau, from lateral to medial. This could be the cause of the genu varus deformity seen in some adult mice. As the STR/ORT has some pedigree as a murine form of OA this might be linked to genu varum in Man.

POSTER 1110

A radiological technique for the assessment of wear in prosthetic knee replacements

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PURPOSE: Röntgen stereophotogrammetric analysis (RSA) is the accepted gold standard for assessing wear of the polyethylene articular surface in hip and knee joint replacements. RSA is both expensive and time-consuming and is generally available only in academic centres. The purpose of this study was to evaluate a simple, digital fluoroscopic technique for the assessment of wear in knee prostheses. MATERIALS AND METHODS: A Phillips MD 3 fluoroscopy unit was used to image a number of small ball-bearings of different sizes and a phantom prosthesis. Images of the prosthesis were produced by aligning the surface of the tibial plateau parallel to the X-ray beam. Additional images were produced in degrees of craniocaudal and lateral angulation. Calibration of the measurements was made by reference to known diameters. Images of the ball-bearings were evaluated to determine the effects of magnification and measurement reproducibility. Measurements of the depth of the polyethylene layer of the prosthesis were made to assess reproducibility of positioning, interobserver and intraobserver variance and the effect of angulation. RESULTS: Reproducibility of the measurements of the ball-bearings was high for diameters of 5 and 10 mm (variance 0.0027 mm^2). Operator positioning of the prosthesis was reliable. Both interobserver and intraobserver agreement of measured polyethylene depth was high (*e.g.* medial joint thickness range 4.9–5.2 mm, variance 0.0058 mm^2). Angulation effects limited by the technique were negligible. CONCLUSION: In summary, we describe a simple, reproducible, cheap and accurate technique for assessment of the depth of polyethylene in knee prostheses which may be used in follow-up studies to assess wear.

POSTER 1111

MRI of giant cell tumour of tendon sheath of the foot and ankle

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OBJECTIVE: We retrospectively reviewed five histologically proven cases of giant cell tumour of the foot and ankle to define MRI features of this entity and to establish the role of MR in preoperative diagnosis of the soft tissue tumours in the foot and ankle. MATERIALS AND METHODS: The case records and MRI findings in five cases of GCTTS were reviewed. MRI included T_1 weighted SE, T_2 weighted FSE, STIR and T_1 weighted SE with Gd-DTPA enhancement. RESULTS: All the lesions were well defined masses in the foot and around the ankle. All of them were of intermediate signal intensity on T_1 weighted images. On T_2 weighted sequences, three of the lesions were of intermediate signal intensity and two were of low signal intensity owing to presence of haemosiderin and fibrous tissue. CONCLUSION: MR features of the GCTTS are characteristic but not pathognomonic for this entity. MR is useful in reducing the differential diagnosis of the soft tissue tumours of the foot and ankle. It is helpful in pre-operative assessment and post-operative follow-up to rule out recurrence.

POSTER 1112

Acute hyperflexion injury of the foot: is primary diagnostic work-up with conventional radiography sufficient?

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PURPOSE: To evaluate the diagnostic accuracy of conventional radiography, CT and MRI in the detection of ligamentous and bony changes in patients after hyperflexion injuries of the foot. PATIENTS AND METHODS: 50 patients after acute hyperflexion injuries of the foot were included in this study. Conventional radiographs and stress radiographs were obtained in the least three planes. All patients underwent CT examinations with the scan plane parallel to the dorsum of the foot (slice thickness 2 mm, sequence scan modus) and MRI in oblique axial (parallel to the dorsum of the foot), sagittal and coronal images using T_2 FSE, T_1 SE and STIR sequences. RESULTS: Conventional radiographs were the least sensitive modality in the detection of bone fractures and tarsometatarsal joint malalignment (indirect sign for ligament pathology). CT was more sensitive in the detection of tarsal and metatarsal fractures and joint malalignment compared with plain films, resulting in a change of the therapeutic management in 32 patients. MRI was highly sensitive in the assessment of fractures (even occult fractures) and was the only modality allowing the assessment of the Lisfranc ligament. However, compared with CT, MRI did not show any finding which led to a different therapeutic management. CONCLUSION: Conventional radiographs, including weight-bearing films, are not sufficient in the routine diagnostic work-up of patients with hyperflexion injuries. Tomographic imaging modalities as CT and MRI should also be performed. In our study, CT was the less expensive modality compared with MRI, and appeared to be sufficient in the detection of tarsal and metatarsal fractures and joint malalignment in patients after hyperflexion injuries.

POSTER 1113

Imaging features of musculoskeletal amyloidosis

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Amyloidosis is the extracellular fibrillary deposition of protein mucopolysaccharide complex. Its primary form is associated with light chain AL protein while AA (amyloid A) protein deposition predominates in amyloidosis secondary to rheumatoid arthritis, sepsis, inflammatory disorders and cystic fibrosis. In chronic haemodialysis amyloid is composed of beta-2 microglobulin. Radiology was reviewed over a 7 year period to August 1998 in patients at Charing Cross Hospital. Radiological features of articular and periarticular amyloidosis are presented in patients on long-term haemodialysis. Although non-specific, the appearances suggestive of amyloid infiltration are shown in plain radiographs and CT.

Neuroradiology

POSTER 0301

A simple technique for prescribing imaging slices in MRI of the hippocampus

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INTRODUCTION: The use of non-orthogonal imaging planes parallel and perpendicular to the hippocampal long axis is of value in the MRI detection of mesial temporal sclerosis. Accurate prescription of these planes may be problematical. This presentation describes a simple, reproducible method for prescribing non-orthogonal MRI sections axial and coronal to the hippocampus. METHOD: Cranial 3D magnetization-prepared rapid acquisition gradient echo (MP-RAGE) datasets were acquired on 106 consecutive patients without intracranial mass lesions presenting for MRI. Standard MRI console software was used to determine the angle

between the anterior commissure–posterior commissure (AC–PC) line on the mid-sagittal section and a line drawn along the long axis of the temporal lobe tangential to the subiculum on a parasagittal section (bicommissural–hippocampal angle, BHA). RESULTS: Seven patients were excluded because of movement artefact. Mean BHA was 25° (SD 0.92°). BHA was exactly 25° in 84/99. In 96/99 BHA was within ±2° of 25°. CONCLUSION: The AC–PC line is easily identifiable from a central sagittal section. Prescribing sections through the hippocampus by determining a plane 25° to the AC–PC line is quick and simple to perform. Familiarity with the detailed anatomy of the temporal lobe in parasagittal section is non-essential. Radiologist input is not required. This technique allows optimal placement of scanning sections coronal to the hippocampal body and in the hippocampal axial plane.

POSTER 0302

MRI of the trigeminal nerve: anatomy and pathology

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The trigeminal nerve is the largest cranial nerve. It has an extensive nuclear distribution, from mid-brain to cervical cord, and is vulnerable to a range of pathological processes. MRI, with its multiplanar imaging capabilities, has greatly facilitated the diagnosis of trigeminal nerve disorders. This presentation reviews the detailed imaging anatomy of the trigeminal nerve, with reference to selected MRI techniques and imaging sections. The common pathologies involving the trigeminal nerve are illustrated and discussed.

POSTER 0303

Imaging findings in cases of hydatid disease of the brain

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PURPOSE: The aim of our study was to reveal cerebral hydatid disease (echinococcosis) using CT and MRI. A correct pre-operative diagnosis is extremely important for choosing the appropriate surgical tactics. MATERIALS AND METHODS: In the period 1992–1998, patients with echinococcus granulosis confirmed by surgery were studied. We found 11 patients (7 male, 4 female) with echinococcus cysts of different localization of the brain parenchyma. The age of patients varied from 2 to 32 years. Patients with hydatid disease of the brain (eight cases) complaining only of headache had no focal neurological signs. Three cases clinically presented with focal seizures and increased intracranial pressure. RESULTS: In two patients, in addition to intracerebral localization we found echinococcus cysts in the liver and lungs. In all cases of hydatid disease of the brain demonstrated on unenhanced CT scans, cysts appeared as large, well defined unilocular cysts with sharp margins, with compression of the lateral ventricle. One side of the cyst was in close contact with the calvarium in two cases. On MRI, hydatid cysts appeared as cystic lesions hypointensive on T_1 and hyperintensive on T_2 weighted images, similar to cerebrospinal fluid. The parietal lobe was the region most commonly involved. In three cases cysts were located in the frontal region. None of the cases showed contrast enhancement or surrounding oedema. CONCLUSION: Thus, CT and MRI provide complete information for the diagnosis of intracerebral echinococcus cysts, allowing the appropriate surgical tactics to be chosen and preventing an anaphylactic reaction owing to cyst rupture during the operation.

POSTER 0304

Cerebral amyloid angiopathy: radiological–pathological correlation of an underdiagnosed entity

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PURPOSE: To identify the consistent CT features of cerebral amyloid angiopathy related intracerebral haemorrhage to assist future recognition of cerebral amyloid angiopathy. MATERIALS AND METHODS: We prospectively collected the clinical records and brain imaging of patients dying following an intracerebral haemorrhage, found at post-mortem to have cerebral amyloid angiopathy. We reviewed the brain imaging to identify common features of the haemorrhage and the remainder of the brain. Seven patients (4 female, 3 male, age range 60–86 years) were examined over a 30 month period. RESULTS: Recurrent, multiple, spontaneous and often large supratentorial intracerebral haemorrhages which extended through the cortex to the subarachnoid space or into the ventricles were consistent features. CONCLUSION: There are characteristic CT appearances of non-traumatic intracerebral haemorrhage in the elderly which are highly suggestive of underlying cerebral amyloid angiopathy. We suspect this entity is under-recognized in life.

POSTER 0305

MultiHance in the assessment of intracranial tumours: results of MRI studies in 120 patients

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INTRODUCTION: MultiHance is a novel gadolinium-based contrast agent which is particularly suitable for MRI of the liver. The present study was performed to assess the safety and efficacy of 0.1 and 0.2 mmol kg^{-1} MultiHance for contrast enhanced MRI of the central nervous system (CNS). MATERIALS AND METHODS: A total of 120 patients was enrolled in 13 phase II studies. Administration was by intravenous infusion at 10 ml min^{-1} and images were obtained pre-dose (T_2 weighted and T_1 weighted SE sequences) and at 0–15, 15–30, 30–45, and 45–60 min post-dose (T_1 weighted SE sequences). Qualitative efficacy assessments were performed by two blinded, experienced radiologists. Safety and tolerability were evaluated by means of physical and neurological examination, 12-lead ECG, vital signs, laboratory investigations and adverse events (AEs). RESULTS: Overall diagnostic information was improved in 58.6–78.9% of patients administered 0.1 mmol kg^{-1} MultiHance and in 66.1–74.6% of patients administered 0.2 mmol kg^{-1} MultiHance; in most cases thanks to improved lesion conspicuity. The early post-contrast image sets were preferred and no clear differences between the doses were observed. In patients with metastases, a higher number of lesions was detected in 53.6–66.7% of patients at 0.1 mmol kg^{-1} and in 58.3% of patients at 0.2 mmol kg^{-1}. The radiological utility of MultiHance was good to excellent in 91.4% of the patients at both doses. A total of 12/120 patients (10%) reported 15 AEs of which eight were adverse reactions (ARs). All ARs were transient, of mild to moderate intensity, and required no medical action. No laboratory or ECG AEs were reported, and there were no significant alterations in vital signs or laboratory parameters. CONCLUSION: MultiHance is safe and effective for the MR assessment of brain tumours when administered intravenously at doses up to 0.2 mmol kg^{-1}.

POSTER 0306

Metastatic spectrum of malignant melanoma in the central nervous system

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PURPOSE: To evaluate the sites and pattern of metastatic malignant melanoma spread within the central nervous system (CNS) on CT and MRI. MATERIALS AND METHOD: CT and MR scans of 23 patients with known metastatic malignant melanoma and CNS involvement were reviewed over a 2 year period. Of the 23 patients, there were 11 males and 12 females with an age range of 31–69 years. Contrast enhanced CT scans were performed in all 23 patients; however, only five patients had further imaging with Gd-DTPA enhanced MR. RESULTS: The patterns of spread fell predominantly into three groups: brain parenchyma only ($n=16$), meningeal only ($n=4$) and both parenchymal and meningeal involvement ($n=3$). Of these lesions 19 were supratentorial whilst four had supratentorial and infratentorial spread. Other sites of spread included orbital muscles ($n=1$), intraventricular ($n=1$), scalp soft tissue ($n=1$), epidural causing spinal cord compression ($n=1$) and maxillary antrum ($n=1$). CONCLUSION: Metastatic disease in malignant melanoma does not spare any part of the CNS, with rare sites of spread described above. Subtle meningeal disease is best delineated with contrast enhanced MRI. A pictorial review of common and atypical locations is presented.

POSTER 0307

Primitive neuroectodermal tumours: typical CT and MR findings

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PURPOSE: Primitive neuroectodermal tumours (PNET) are highly malignant, undifferentiated supratentorial neoplasms which frequently seed in the central nervous system. PNET occur primarily in young children; in adults they are extremely rare. Previous reports on the neuroradiological findings refer solely to PNET in children. MATERIALS/METHODS: The CT scans and MR images of five adults (3 males, 2 females) with histologically proven PNET of the cerebral hemispheres were reviewed retrospectively. RESULTS: In this series, PNET were rather large, heterogeneous masses with cystic and necrotic areas, intratumoral haemorrhage and focal calcification. In four patients, the tumour showed well defined margins

on CT as well as MR with only a thin rim of oedema. In three patients, the tumour mass was isodense or hyperdense on NECT scans, presumably as a result of the high nuclear to cytoplasmic ratio found in PNET. MR images showed the tumour to be mildly hypointense on T_1 weighted images and hyperintense on T_2 weighted images. The prominent contrast enhancement on both CT and MR scans reflects the increased vascularity of PNET. CONCLUSION: Understanding PNET is important for the radiologist because certain neuroradiological features may suggest their diagnosis. Because of their propensity to spread throughout the cerebrospinal fluid pathways, an MR examination of the spinal canal should be performed if a PNET is suspected.

POSTER 0308

MR angiography in atypical meningiomas

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PURPOSE: Meningiomas are the commonest primary non-glial intracranial tumours. Vascularity of tumour is significant for surgical intervention, so that evaluation of the possibilites of time of flight (tof) MR angiography (MRA) in atypical meningiomas in important. MATERIALS AND METHODS: 45 patients with brain meningiomas were studied. The locations of tumours were convexital 11 (24.44%), parasagittal 8 (17.77%), falx meningioma 2 (4.44%), middle fossa 9 (20%), posterior fossa 5 (11.11%), frontoorbital 4 (8.88%), tentorial 2 (4.44%), clivus 1 (2.22%), intraventricular 2 (4.44%), orbital 1 (2.22%). For validation of the MRA results in 33 cases, catheter angiography was performed. All patients underwent surgery and histological confirmation of tumour origin was obtained. MRI was performed with axial T_1 and T_2 weighted SE sequences, axial and sagittal scans were performed after the intravenous administration of Omniscan. MRA performed using tof technique on axial scans (for intracranial arteries: fi3d - TR 56 ms, TE 10.4 ms, flip angle 40°; for intracerebral veins: fl2d - TR 51 ms, TE 14 ms, flip angle 60°). Maximum intensity projection (MIP) on axial and coronal planes was carried out. RESULTS: MRA examination was positive in all cases. MRA could not demonstrate vascular shunting and neoplastic blush, but revealed marked enlargement of dominant feeding arterial vessels (38 (84.44%)) and draining veins (42 (93.33%)), and relation of tumour tissue to adjacent dura. In addition, if tof is performed following contrast enhancement it can present as vascular pseudomass, analagous of hypervascular mass on catheter angiograph in mid-arterial phase 34 (75.55%). T_1 and T_2 weighted images gave complete information about tumour growth, and about sinus damage in cases of sinus thrombosis. Malignant lesions were not distinguished from benign lesions by any quantitative signal intensity and MR vascularity parameters. CONCLUSION: MRA is a highly sensitive method of detecting vascularization of meningeal tumours and reveals feeding and draining vessels to aid operation. Contrast enhanced MRA improves general angiographic quality and visualization of blood vessels compromised by tumour. Post-contrast vascularity is not associated with malignancy of tumour, but can help to differentiate from other enhancing lesions.

POSTER 0309

Asymptomatic cervical spondylosis in multiple sclerosis

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PURPOSE: To document the incidence of MRI features of cervical spondylosis in multiple sclerosis (MS) patients without symptoms related to the cervical spine. METHODS: The MRI examinations of 54 patients (median age 40.5 years, range 23–67 years) with MS were reviewed. 52/54 had no symptoms which could be attributed to cervical spondylosis; two possibly symptomatic patients were excluded. Sagittal T_1 and T_2 weighted spin echo and axial T_2* weighted images were obtained through the cervical spine. Images were scored for the presence of disc narrowing, endplate changes and disc protrusion. Signal change within the spinal cord was also documented. RESULTS: 33% of patients aged 40 years or less and 62% of patients over 40 (46% in total), showed MRI signs of cervical spondylosis. The C5/6 interspace was most commonly affected (42%). 52% of patients showed signal hyperintensity within the cord, consistent with demyelination. Most commonly this involved the upper cervical cord (55% lesions above C4). In 15%, cord lesions corresponded with the level of a spondylotic disc abnormality. CONCLUSION: MRI features of cervical spondylosis are common in asymptomatic patients with MS. The incidence of cervical spondylotic changes on MRI in relation to age is similar to that of published figures for asymptomatic members of the general population. No association is noted between site of cord lesions and concomitant degenerative disc pathology.

POSTER 0310

Evaluation of the vertebral arteries in cervical injuries by colour duplex sonography

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PURPOSE: To reveal the association between abnormal findings of the vertebral arteries and the persistence of post-traumatic symptoms (such as vertigo) in patients with cervical injuries within a year from the time of the injury. MATERIALS AND METHODS: The vertebral arteries in 23 patients with post-traumatic symptoms (such as vertigo) during the first year after their cervical injury were evaluated with colour duplex sonography. Stenosis of the carotid artery was less than 50%. RESULTS: Four cases of unilateral and two cases of bilateral vertebral artery stenosis were detected from the total of 23 patients. In addition, one case with unilateral subclavian steal syndrome was revealed. CONCLUSION: In patients who have suffered from cervical injury and whose symptoms persist after a period of some months from the time of the injury, evaluation of the vertebral arteries by colour duplex sonography should be considered.

POSTER 0311

Spiral cervical CT myelography in adult brachial plexus injury

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Accurate pre-operative assessment of the brachial plexus is essential in planning the surgical approach and determining the prognosis. Thin section CT myelography is the best imaging modality compared with conventional myelography and MRI in pre-operative diagnostic assessment to determine the precise type and level of injury which complements the clinical examination. We present a pictorial review of patients with brachial plexus injury, demonstrating a normal appearance and the range of pre-ganglionic injuries such as avulsion and psuedomeningoceles formation. Surgical and intraoperative somatosensory evoked potential (SEP) correlation is available in all cases and the impact of imaging on surgical management is discussed.

POSTER 0312

Withdrawn

Physics

POSTER 1501
A simple and realistic tissue equivalent breast phantom for MRI
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PURPOSE: To design an inexpensive tissue equivalent breast phantom which could be used to test a variety of MRI sequences. MATERIALS AND METHODS: Studies were performed using a 1.5 T GE Signa and a commercial breast coil. Various materials were examined for their similarity to breast tissue in terms of relaxation time and resonant frequency. T_1 measurements were performed using the variable flip angle technique, which utilizes the signal intensity ratio of two different gradient echo sequences. Absolute values of T_1 were derived from this ratio using a calibration curve produced for test objects of known T_1. Materials were investigated at two ambient temperatures and various concentrations. 10 women were also examined to determine the range of T_1 values found *in vivo*. The final phantom design consisted of a layer of lard, to simulate adipose tissue, surrounding a commercial jelly product to simulate parenchyma. "Enhancing lesions" were incorporated into the phantom by suspending small capsules of gadolinium-doped water. RESULTS: *In vivo* studies revealed mean T_1 values for parenchyma of 773.8 ± 183.0 ms and 226.7 ± 41.6 ms for adipose tissue. T_1 values for the fat equivalent material were 165.7 ms at 6 °C, and 204.5 ms at 21 °C. Values for the jelly product varied with concentration (355.2–1061.2 ms at 6 °C, 484.4–1394.0 ms at 21 °C). CONCLUSIONS: The phantom effectively simulates MR images of the breast and enables multipurpose quality assurance tests to be performed, including fat suppression.

POSTER 1502
AEC — through thick and thin?
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Automatic exposure control (AEC) is a widely used method for obtaining acceptable film densities on radiographs over a range of exposure conditions. It is important to test AEC devices, as their performance directly affects patient dose and the diagnostic value of radiographs. The recently revised Institute of Physics and Engineering in Medicine (IPEM) document (TGR 32 part IV) suggests an appropriate testing protocol and tolerances. In attempting to implement this protocol we have encountered several problems: (a) the choice of attenuator used to simulate differing patient thicknesses can influence whether or not the unit passes or fails; (b) the relevance to clinical practice of the tests, in particular the range of kVp and attenuator thickness and whether these should be tested as independent variables; (c) the idiosyncrasies of particular manufacturers in the set-up of the AEC unit, for example, setting the central chamber to be more sensitive than the outer two. The results of our investigations into these problems, and our attempts to solve them, will be described. Surveys were also carried out to obtain feedback from the radiographers on their use and perception of AEC units. Staff were asked to score images of an anthropomorphic phantom, and complete questionnaires on the use of chest units and choice of kVp for a sample of "patients". The results of these surveys and their implications for the testing of AEC units will be discussed.

POSTER 1503
Transverse relaxation time as a predictor for Young's modulus of elasticity of cancellous bone *in vitro*
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PURPOSE: Transverse relaxation time (T_2^*) of intertrabecular fluid, measured from MR images of cancellous bone, reflects the mechanical properties of the tissue. We wished to determine if the assumption of a monoexponential decay of signal intensity (I) as a function of echo time (TE) is valid in cancellous bone and how the predictive capacity of T_2^* varies as a function of TE range. METHODS: Young's modulus of elasticity (E) was determined in the three orthogonal directions in five cubes of bovine cancellous bone. MR images were obtained in three orthogonal planes using a 2D gradient echo sequence at 11 TE values between 5 ms and 65 ms. Curve fitting routines were applied to the I *vs* TE data to determine the best fits over differing ranges of TE. RESULTS: Plots of ln I *vs* TE were markedly non-linear suggesting non-monoexponential behaviour. Changing the range of TE over which T_2^* is calculated affected the predictive capacity for E. The most effective TE range was 5–35 ms where a combination of T_2^* and $1/T_2^*$ explained approximately 80% of the variance in 1/E. CONCLUSIONS: The relationship between signal intensity and TE does not appear to be a simple monoexponential function and the range of TE over which T_2^* is calculated affects the predictive capacity of this variable for E. Both points should be considered when developing protocols for measuring T_2^*. Work is ongoing to determine the exact nature of the relationship between I and TE, particularly to assess the significance of correcting for non-zero average background in the MR images.

POSTER 1504
An investigation into tissue and blood mimicking materials for an MR angiography phantom
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PURPOSE: MagNET, the UK magnetic resonance assessment team, have developed a protocol to investigate the image quality of angiographic sequences on MRI scanners from different manufacturers. The aim of the work presented here is to achieve clinical relevance and verify reproducibility of the technique. METHODS: A gel with T_1/T_2 values and elasticity similar to that of tissue has been chosen as a phantom material. In our previous work, an oil-based fluid was used to mimic blood. However, the properties of this fluid vary with time and temperature, causing inconsistency in the results. The properties of a glycerol solution have been investigated for use as a blood mimicking fluid. A computer controlled flow system filled with this solution is used to produce pulsatile flow through the MR angiography (MRA) phantom. The phantom was scanned several times on an MR system using a 2D time of flight sequence (TE = 7 ms, TR = 25 ms, flip angle = 60°, matrix = 256 × 256, FOV = 160 mm, slice thickness 2 mm). Images were also acquired from different MR systems. RESULTS: Images obtained were analysed, demonstrating reproducibility of the method suggested. Results of different systems are presented for comparison. CONCLUSION: We have developed a protocol for comparing MRA sequences of different manufacturers. Results acquired during MagNET's type-testing of MR systems are included in blue cover reports.

POSTER 1505
Adaptation of dual energy X-ray absorption to provide tomographic information
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A dual energy absorption system has the advantage of involving a very small dose to the patient. In the measurement of fat content, and other body composition studies, there are often three or more tissue types lying along the path of the beam, and the information provided can be ambiguous. The ambiguity can be removed by tomographic scanning, but at the expense of a much higher dose. The present work investigates whether scanning over a narrow range of angles, which might be possible on a standard dual energy absorption system, can also provide a significant improvement in image quality. Simulations for a single energy show the expected loss of image quality as the number of ray directions, and the range of angles, decrease. It is found that much of this loss can be regained when information from the second X-ray energy is added. Phantom studies are also described, in which a rigid phantom is rotated through a small angle between scans, but patients must lie still, to

achieve a stable distribution of tissue types, and so clinical measurements will require an array of separate detectors. It is concluded that a simple enhancement of the system will provide quantitative tomographic information, which will be valuable for body composition studies.

POSTER 1506
Development of evaluation techniques for dedicated MRI systems
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PURPOSE: Dedicated MRI systems are becoming established in the UK with a current installed base of five systems, primarily in the field of orthopaedics. At present, no comparative method of performance assessment is available. The aim of this study was to continue and expand on previous work by MagNET on the development of dedicated test objects, scan protocols and analysis techniques in order to highlight the capabilities and limitations of such systems. METHOD: Six test objects were used, five cubic (flood field, slice width, contrast, bar resolution and modulation transfer function) and one wrist size (flood field). The study was performed using the UK installed dedicated MR systems and the results were analysed and compared for reproducibility. Standard MagNET protocols were used as the basis for image sequences with parameters adjusted accordingly for the dedicated systems. RESULTS: Images and analysed data from each test system are presented and compared in respect of quality parameters such as geometry, signal-to-noise ratio, and resolution. CONCLUSIONS: Comparison of the results from the test systems indicates that the test objects and dedicated MRI systems generate reproducible images. The method of analysis and the scan protocol tested are suitable for use in type-test evaluations of dedicated MRI systems.

POSTER 1507
The measurement and simulation of noise in clinical CT images
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A technique for measuring the level of noise in clinical CT images of the head and the simulation of Poisson-distributed noise has been developed. Noise was measured from regions of interest (ROIs) in the lateral ventricles (LV). Validation was performed by acquiring three identical images at 420 mAs and one at 300 mAs. The first was used to measure the noise in the LVs, the second and third were subtracted from each other and used to measure structureless noise in the same and other regions. Noise was added to the 420 mAs images to simulate 300 mAs images by adding Poisson-distributed random numbers to each pixel depending on the level of noise measured in the clinical (420 mAs) image. Validation of the simulation was by comparison with the acquired low 300 mAs image. Analysis of 17 such images showed a 27% difference in the average percentage difference of the noise values in the LV regions between the simulated and acquired low mAs images, based on a three pixel radius ROI. The simulated and acquired low mAs images were also compared subjectively by observer inspection with no observable difference being reported. Optimization of the ROI shape, position and size is still under investigation in order to reduce to the large variability in noise seen in some images, even though the technique works well for most cases.

POSTER 1508
Minimization of geometric distortions in MRI
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PURPOSE: To minimize geometric distortions in MR images by pulse sequence optimization to enable MR based radiotherapy treatment planning. MATERIALS/METHODS: All MRI data were acquired using a 1.5 T IGE Signa scanner equipped with a maximum gradient field strength of 22 mT/m. Potential image distortions were assessed using two air/water phantoms of outer dimension 26 cm each containing a series of Perspex tubes. Field of view (FOV), receiver bandwidth, echo time, and echo train length were individually varied in an axial 2D fast spin echo sequence to assess the dependence of geometric distortions on these parameters. Distortions were calculated by comparing the measured distances between each tube and the central one to the actual phantom dimensions. RESULTS: Variation of either echo train length or echo time had no effect on geometric distortion with an average distortion in tube position of 0.7 mm. Increasing receiver bandwidth reduced average distortion from 1.62 mm at a bandwidth of ± 2 kHz to 0.67 mm at ± 64 kHz. Geometric distortions were reduced at a smaller FOV — from an average distortion of 1.01 mm at a 48 cm FOV to 0.68 mm at a 28 cm FOV. CONCLUSIONS: Geometric distortions are minimized at a reduced FOV with a large receiver bandwidth. In this situation the resultant average distortion of 0.7 mm is well within the tolerance limits of radiotherapy treatment planning. The requirement of a reduced FOV implies that external fiducals markers used in treatment planning are best situated as close to the skin surface as possible. Since the extent of geometric distortion is independent of echo time and echo train length, both of these parameters can be adjusted to optimize clinical contrast.

POSTER 1509
The use of high density metal foils to increase surface dose in low energy clinical electron beams
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This paper describes a practical method of elevating the surface dose of clinical electron beams in the energy range 3–12 MeV using thin high density metal foils (tin and lead) as an alternative to tissue equivalent bolus. Since relative to water these materials exhibit a high linear scattering power to linear stopping power ratio, the desired dose elevation is achieved with less energy loss than conventional bolus and consequently a modest gain in therapeutic interval. The thickness of the foil required to raise the surface dose to 90% of peak, for a given electron energy, was calculated using standard scattering and stopping powers. Measurements to confirm the predictions of the theory were made. These were in good agreement.

POSTER 1510
Patient-held radiology records using smart card technology
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PURPOSE: To establish if patient-held radiology records can be held on a "smart card" equivalent with appropriate security and ease of updating. MATERIALS AND METHODS: 30 folders with a minimum of five investigations per folder using library films of different imaging methods were assembled to simulate patient records. These were digitized using either a Hewlett Packard ScanJet 4C/T or a Cobrascan scanner at 600 dpi and saved as compressed JPEG files. Images were transferred to either a credit card sized laser card (Drexler 2.48 MB uncompressed capacity, using Conlux Laser Card readers and a networked Viglen 486S X25 computer running Win3.11) or a re-writeable CDROM (650 MB uncompressed capacity, using TraxData CDRW2260 CD reader/writer, on a Viglen Contender ATX P5/166, running MS Win95). 30 volunteers were used to hold the records and asked to re-attend at intervals to update their records. RESULTS: Laser cards: the average size of each stored file was 100 kBm; total card capacity of 20–25 files. Each card was password protected. Time for data management range (35 min–1 h 5 min). Printed reports were scanned and saved as compressed JPEG files, occupying 20–30 kB each. Cards were unaffected by magnetic interference and were resilient to creasing or breaking and were convenient to store. CDROM file capacity was 5500, an additional 20 MB was required for writing to the CD. Each disk could be password protected. Time for data storage was comparable to the laser card. CDROMs were supplied in CD jewel cases but were inconvenient to carry. Volunteers attempted to read their own CDROMs, increasing the security risk and risk of surface damage. Scanned images in both formats were used for reporting, at 600 dpi resolution. CONCLUSIONS: Digital patient-held data storage was convenient and secure with good but slow data storage and retrieval. Laser cards were more convenient to use in view of their physical dimension and greater security despite their lower capacity.

Radiation Safety and Protection

POSTER 1401
Modification of T-lymphocytes activation markers expression in people living in radiation contaminated areas in the Ukraine
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PURPOSE: To determine the effects of low doses of radiation of the T-lymphocytes activation markers expression in Ukrainian people following the atomic accident in Chernobyl. MATERIALS/METHODS: The patients were divided into two groups. Group 1:

people living in Central Ukrainian Cities where radioactive contamination is 1–5 mKi km^2. Group 2: residents from radiation-free areas in the Ukraine. The study was carried out using immunofluorescence staining with Anti-Leu-3a FITC + Anti-Leu-2a PE; Anti-Leu-3a FITC + Anti-HLA-DR PE; Anti-Leu-3a FITC + Anti-IL2PE. RESULTS: The unproportional decrease of the CD4 + and CD8 + lymphocytes in participants affected by low doses of radiation. The promotion of the reduction of the immunoregulating index (CD4 + /CD8 + ratio). The expression CD4/CD25 and CD4/HLA-DR markers on the lymphocytes was enhanced following the atomic accident. An increase in the apoptosis related CD4 + 8 + lymphocytes was revealed. CONCLUSION: Low doses of radiation could stimulate programmed cell death in lymphocytes.

POSTER 1402

The use of a human *in vitro* model to screen the placental transfer of radiopharmaceuticals

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PURPOSE: Placental transfer data for radiopharmaceuticals is usually available only from animal studies. Such studies are increasingly expensive, time-consuming and morally debatable. This study was undertaken to determine whether a human *in vitro* perfused placenta experimental model could be used to screen radiopharmaceuticals for their ability to cross the placenta, providing data which would allow animal studies to be targetted to radiopharmaceuticals most likely to reach the fetus. METHOD: Human placentas were obtained immediately after normal term spontaneous delivery, or elective Caesarean, from women where there had been no fetal distress or meconium staining of liquor or placenta. Placentas were transferred to a purpose-built perfusion cabinet maintained at 37 °C and maternal and fetal circulation of an isolated cotyledon perfused at physiological pressure with oxygenated heparinized tissue culture medium (199). This model provides the best available approximation to the dynamics of the placenta *in vivo* and has been assessed and validated in physiological terms. The transfer of antipyrine and creatinine was used as an internal control to provide an index of the efficiency of perfusion. The transfer of sodium-99m pertechnetate, ^{99}Tc^m-MAG3, ^{99}Tc^m-DTPA and ^{99}Tc^m-DMSA was measured by sampling both maternal and fetal perfusion circuits. RESULTS: All four agents crossed the placenta readily with activity transferring to the fetal circulation steadily from the maternal circulation. ^{99}Tc^m-DMSA crossed the placenta to only a limited extent compared with both ^{99}Tc^m-MAG3 and ^{99}Tc^m-DTPA (4–5 fold) and particularly sodium-99m pertechnetate. This ranking is comparable with animal data previously reported.

POSTER 1403

Placental transfer of ^{99}Tc^m-MAG3 — radiation dose to the fetus following renal imaging in pregnancy

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PURPOSE: In susceptible individuals renal function may be impaired during pregnancy. Renal imaging and measurement of renal function using radiopharmaceuticals is a clinical area in which nuclear medicine may offer valuable diagnostic information. This study has measured the placental transfer of ^{99}Tc^m-MAG3, widely used in nuclear medicine for renal imaging and the measurement of renal function, in order to estimate fetal radiation dose following renal scintigraphy in late pregnancy. MATERIALS AND METHODS: ^{99}Tc^m-MAG3 (7 MBq/0.5 ml) was administered by intracardiac injection to guinea pigs in the 6th to 9th week of gestation (equivalent to the third trimester in humans). The maternal and fetal tissue concentrations of radioactivity were determined at intervals up to 5 h after administration. Fetal dosimetry was calculated using MIRDOSE3 software. RESULTS: Up to 0.3% of administered activity accumulated in the feto-placental unit in total. Assuming a similar biodistribution in humans, preliminary calculations suggest that this would result in a fetal dose of 0.7 mGy/100 MBq administered to the mother. The largest contributor to the fetal dose is the activity within the fetus itself with the maternal urinary bladder contributing about 17% of the total. CONCLUSION: Fetal radiation doses from renal investigation using ^{99}Tc^m-MAG3 are likely to be low and pose little risk to the health of the child. These data will be compared with results using ^{99}Tc^m-DTPA, the most common alternative radiopharmaceutical used for renal investigation.

POSTER 1404

Withdrawn

POSTER 1405

Risk of radiation induced skin damage during neuroradiological procedures

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PURPOSE: To identify which neuroradiological procedures are likely to give radiation doses above the threshold value of 2 Gy for skin erythema. METHOD: Archive data over 12 months for cerebral angiograms (CA), Wada tests (WT), GDC and glue (GE) embolizations were analysed. The system software with the Siemens T.O.P. neuroradiology equipment calculates an entrance surface dose (ESD) from a dose–area product by assuming that the focus-to-skin distance (FSD) equals 55 cm and that all the radiation is localized at a single entrance position on the patient. In addition, arrays of thermoluminescent dosemeters (TLDs) were used to measure the maximum ESD on patients for four GDC and six CA procedures. Procedure details were recorded so that the average FSD could be obtained. RESULTS: Using the average FSD of 70 cm (1 SD = 2.5 cm), the maximum calculated ESDs were 1.5 Gy (n = 221 patients), 0.16 Gy (n = 6), 3.9 Gy (n = 22) and 2.1 Gy (n = 13) for the CA, WT, GDC and GE, respectively. 15 of these patients underwent at least two procedures – five of these had a combined ESD over 2 Gy. Only one patient had TLD readings above the threshold (2.8 Gy for a single GDC procedure). As expected, the calculated ESD was always greater than the measured ESD. CONCLUSION: WT do not carry any risk of skin damage. Most CA and embolizations can also be performed with doses below the threshold. Patients who undergo embolizations will often have additional CAs. The total ESD could then be over the threshold for radiation damage.

POSTER 1406

A method for determining effective dose resulting from radiographic examination of the extremities

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PURPOSE: To calculate an effective dose value for a chosen radiographic examination, the radiation dose received by specified organs and tissues must be estimated. The aim of this project is to measure physically the dose received by the appropriate organs and tissues during extremity radiography. MATERIALS AND METHODS: A small silicon semiconductor detector and a sectional anthropomorphic phantom were used for this purpose. The majority of organ and tissue sites were located within the phantom using previously published work. The method described here utilized a grid system which was applied to each slice, with the various organs and tissues at specific grid references. The remaining organs and tissues were sited using a CT atlas and Reference Man data, to produce a complete set of locations for all the specified organs and tissues for both the trunk and the extremities. For data collection, the appropriate slice was removed and the detector was placed at an organ site. A tissue-equivalent gelatine and water mixture was used to pack around the detector and an exposure was made for an extremity examination. Specific mass fractions for each slice were then applied

to the organ dose. The average dose to an organ within a slice is weighted using the mass fraction value. The total fractions are then summed to produce an organ dose. This dose is then weighted using the International Commission of Radiation Protection Publication 60 and the effective dose can be obtained. RESULTS AND CONCLUSION: This method of determining effective dose is suitable for an anthropomorphic phantom and a small detector with sufficiently high sensitivity.

POSTER 1407

Scattered radiation dose around a C-arm image intensifier used in orthopaedic theatre

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PURPOSE: To comply with staff doses being as low as reasonably practicable (ALARP) it is usual to recommend that C-arm image intensifiers are operated with the tube below the patient to minimize the scattered dose. Orthopaedic surgeons operating on extremities frequently challenge this recommendation on the grounds of practical difficulty and the fear of exposure to the primary beam from the upwards pointing X-ray tube. This study evaluates the optimum geometry for minimizing staff dose. METHOD: Ion chamber measurements of the dose around extremity phantoms were made with the tube both below and above the phantom. RESULTS: For larger extremities where the operating voltage exceeded 55 kVp there was a dose advantage to operating with the tube below the patient. Below 55 kVp there was no such advantage. CONCLUSION: For smaller extremities (wrist, arm, ankle) where the operating voltage is below 55 kVp, the image intensifier may be operated with the tube above the patient without contravening the requirement that dose to staff be ALARP.

POSTER 1408

Effect on fetus dose from chest X-ray of the mother: high kilovoltage technique *vs* low kilovoltage technique

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Diagnostic X-rays are occasionally performed on pregnant women. A low kilovoltage (kV) technique is traditionally employed for chest radiographs but is gradually being replaced by a high kV technique. A high kV technique may not be suitable for pregnant women in view of a potentially higher radiation dose to the fetus from scatter. A comparative study was carried out to determine the radiation exposure to the fetus using these two techniques. A water phantom was employed to simulate the thorax, and a slab of Perspex was used to mimic the tissue from thorax to the fetus. The X-ray field size was set to 30 cm × 30 cm with the edge aligned with the interface of the phantom and the slab of Perspex. Fetal dose was measured with a calibrated ionization chamber using the two techniques at 100 cm focus-to-film distance. The patient absorbed dose was calculated as the difference between the entrance dose and exit dose which were measured with the ionization chamber positioned in the centre of the field of view. Our results indicate that fetal dose may be more than two times higher using a high kV technique compared with a low kV technique, although the mother's dose may be decreased by about 15%. It would appear that a low kV technique would be more appropriate for chest radiography of pregnant women. Thus, we recommend the use of a low kV technique for imaging pregnant women to minimize radiation hazard to the fetus.

POSTER 1409

Deterministic effects in diagnostic radiology

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PURPOSE: To compare current methods of dosimetry for the measurement of entrance surface skin dose (ESD) for fluoroscopically guided cardiac and neurological interventional procedures and to establish local reference dose levels based on ESD measurements obtained during the survey. The survey is to include a number of local hospitals. MATERIALS AND METHODS: For a 6 month period between November 1998 and April 1999 all patients undergoing high dose procedures are to be monitored for ESD levels using a number of commercially available methods of dosimetry. The ESD measurements are to be tabulated for both procedure and hospital. RESULTS: A comparison of the current methods of dosimetry in terms of simplicity, accuracy and clinical compatibility will be made, together with a discussion of the range of ESD levels obtained during the study and the establishment of local reference dose levels based on these measurements for each of the hospitals concerned.

Radiotherapy & Oncology

POSTER 1301

Electronic portal imaging devices machine check films: a comparison of displacement measurements

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PURPOSE: This study was designed during the commissioning of two Theraview electronic portal imaging (EPI) devices to assess the validity of the software function, target check (TC). TC is responsible for measurements of the isocentre displacement for each EPI taken during treatment. The aim of the study was ultimately to replace the conventional verification system using check films (CF) with EPI. The objectives were to establish if the measurements on EPI were comparable to machine CF and if decisions made using the EPI would result in the same action levels as film. METHOD: Fujifilm RX-U was used for the CF. CFs of pelvic treatments were compared with corresponding EPIs. Using the simulator film as the reference, measurements were made of isocentre displacement on the CF and recorded prior to EPI TC. RESULTS: 50 CFs and corresponding EPIs were taken. Measurements of displacements were compared in three planes, producing 100 sets of paired data. Using the t-test, p values were: Rt/Lt = 0.70, Sup/Inf = 0.74 and Ant/Post = 0.90. The correlation coefficients were $R^2 = 0.72$, 0.85, 0.69, respectively. The root mean square error was calculated. Using a tolerance of 2.5 mm the action levels for each measurement were established and agreed in 89% of measurements. CONCLUSION: There is a strong correlation between the systems of measurement, any differences are insignificant. This supports the replacement of CFs with EPIs.

POSTER 1302

Costing distance: a comparison of breast treatment cost

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PURPOSE: The crossover from a non-isocentric technique for treating breast cancer with radiotherapy to an isocentric technique afforded the opportunity to evaluate the change from the perspective of cost. Cost is currently an important element in the National Health Service (NHS) but not always the governing element in the decision making process. METHOD: The bottom-up costing methodology incorporated collecting cost data and information on the utilization of staff and equipment by means of a time study in order to calculate the costs of the two techniques. Costs were calculated for both planning and treatment on the two units normally utilized for these techniques (linear accelerator and cobalt-60 unit). RESULTS: Treatment on both units was significantly longer for the non-isocentric technique ($p = <0.003$ compared with <0.001) which when applied to the separate costing elements gave a cost of £43.83 and £35.72 per fraction on the linear accelerator and £26.76 and £23.08 on the cobalt unit. A variation in cost for planning of the two techniques also existed with isocentric planning, costing £135.16 compared with £100.46 for non-isocentric, the major cost variation arising from use of the simulator. CONCLUSION: Isocentric treatments are less expensive to undertake than non-isocentric, assuming the machine can be utilized during the freed-up time. The cost benefit of the change may be more than shown in the study as the quicker treatment time may negate the need for some overtime work which would be calculated at a higher rate.

POSTER 1303

Monte Carlo calculations of dose perturbation arising from natural and artificial (*i.e.* prosthetic implants) inhomogeneities

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The presence of metal implants and fixation methods used for jaw reconstruction following surgical removal of diseased tissue in head and neck cancer can compromise dose uniformity throughout the treatment volume. This can lead to implant failure and/or treatment failure owing to over or underdosage. In addition, the production of secondary electrons and their transport leads to significant dose perturbations in the vicinity of interfaces between materials of

different atomic number. The perturbation depends strongly on many factors including beam energy, field size, the materials involved and their thickness. Practical measurements of dose in irregularly shaped inhomogeneous phantoms and in the vicinity of interfaces can be difficult to undertake, for example, ion chamber measurements in transition regions where charged particle equilibrium does not exist can be uncertain. The Monte Carlo radiation transport code MCNP-4B has been used to investigate and assess the dose perturbation by non-tissue equivalent materials in three head and neck inhomogeneous phantoms: cubic, spherical and ellipsoidal with titanium and titanium alloy implants. The code is also used to assess the design and clinical application of missing tissue compensators and evaluate compensator modifications for dose perturbations arising from natural and artificial (*i.e.* prosthetic implants) inhomogeneities within the treatment field. The implications of this work for radiotherapy treatment planning will be discussed.

POSTER 1304

Efficacy of high activity ^{111}In Octreotide therapy for disseminated neuroendocrine tumours

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PURPOSE: To perform an initial assessment of the efficacy of radiopeptide targeted therapy of neuroendocrine tumours with high activity ^{111}In Octreotide therapy. MATERIALS AND METHODS: Following a successful phase I toxicity trial, a prospective study was performed to assess the efficacy of high activity ^{111}In Octroetide therapy for neuroendocrine tumours resistant to conventional treatment. 16 patients have received a total of 55 treatments with high activity (2–6 GBq ^{111}In Octreotide) with a 3 week–3 month inter-treatment interval. 12 patients had disseminated carcinoid, two had medullary cell cancer of the thyroid (MCT), one a malignant gastrinoma and one a fibrolamellar tumour. All patients were reviewed for toxicity, and objective and subjective measures of efficacy recorded. RESULTS: All patients tolerated treatment well with only one patient having mild flushing during infusion. There was no evidence of significant hepatic, endocrine or renal toxicity. In the two patients with MCT a good response was seen with reduction in calcitonin. Four patients with carcinoid and a patient with gastrinoma had progressive disease despite treatment. The remaining nine patients had stability of previously progressive disease with some symptomatic relief. CONCLUSION: The treatment remains well tolerated, there is now evidence for efficacy with disease stability in over 50% of patients with disseminated carcinoid and disease regression in MCT.

POSTER 1305

The utilization and delivery of complementary medicine within the oncology centres of England and Wales

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PURPOSE: To investigate the utilization and delivery of complementary medicine within the oncology centres of England and Wales. These results are presented as part of a PhD study into the subject. Since 1990, cancer patients have increasingly requested/used complementary medicine as part of their disease management. Many oncology centres responded by introducing complementary therapies alongside their conventional cancer treatments. MATERIALS AND METHODS: Phase One (postal questionnaire) produced a descriptive analysis/overview by identifying the availability of complementary medicine in the oncology centres, range of therapies provided, condition(s) in which they are utilized and the health individuals/professional groups who administer such treatments. RESULTS: A return rate of 84% (n=47/56) showed that 34 oncology centres (61% of population, 72% of returns) utilize complementary therapies alongside their conventional cancer treatments. These range from aromatherapy (n=27, 79%), relaxation/visualization (n=22, 65%), reflexology (n=18, 53%) and massage (n=18, 53%) to acupuncture (n=8, 24%), and shiatsu/acupressure (n=4, 12%). 23 centres (88%, n=26) use complementary therapies to reduce or relieve stress/anxiety/tension and/or improve general well being, 14 (54%, n=26) use them for pain relief/control. Nurses are the main service providers in 41% (n=14) of centres, therapeutic radiographers (35%, n=12) and complementary practitioners without conventional qualifications (35%, n=12). In centres which do not provide complementary therapies (n=13), eight considered their usage but had not implemented them, seven citing a lack of financial resources as the reason, three also stated that medical staff were opposed. CONCLUSION: Complementary medicine is being increasingly utilized alongside conventional cancer treatments in many oncology centres within England and Wales.

POSTER 1306

Supine MR mammography for demonstrating the extent of breast tissue for radiotherapy

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PURPOSE: Radiotherapy requires a supine position, thus conventional prone MR mammography is unsuitable for radiotherapy planning purposes. No dedicated supine breast coil is yet available, limiting MRI in this area. A technique using a 0.2 T Open scanner has been developed to produce high quality supine breast images suitable for radiotherapy planning. METHOD: The single-sided supine breast technique uses a similar patient position as radiotherapy. A small coil is used as a side-on loop over the patient's shoulder which allows the arms to be raised and abducted. A flat tabletop insert imitates the treatment tabletops. The open design of the scanner allows the breast to be positioned in the field centre, increasing signal-to-noise ratio (SNR). 20 patients undergoing routine radiotherapy of the breast were referred for MRI scans in addition to the routine radiotherapy planning. MR markers were placed on the patient's skin over tattoos corresponding to treatment field borders. A high bandwidth T_1 weighted sequence was performed in transverse, sagittal and coronal planes. Images were assessed by the clinical oncologist to determine whether all breast tissue was included within the treatment field. RESULTS: Images of good diagnostic quality were produced in reasonable scan times. Breast tissue was well demonstrated, particularly in younger, premenopausal women. MR markers allow accurate delineation of the treatment field. Four patients were found to have breast tissue outside the treatment field previously determined by fluoroscopy. CONCLUSION: The single-sided supine technique produces high quality breast images contributing valuable information for treatment planning/assessment. MR provides better discrimination between breast and surrounding fatty tissue than fluoroscopy.

POSTER 1307

Distance dependence of exposure rate from a ^{60}Co teletherapy source

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A gamma ray ^{60}Co source of activity α produces an exposure rate X at a distance d in vacuum, given by $X=\Gamma(T)\alpha/d^2$, where $\Gamma(T)$ is the theoretical specific gamma ray constant, which has a value of 3.562×10^5 R cm^2 (h TBq)$^{-1}$. It is shown that the formula is accurate to 0.1% for a cylindrical source of length l provided that $d/l \geq 5$ and that the distance is measured from the centre of the source. When absorption in the source and scattering in the collimator are considered, the position of the origin $d=0$ can shift by a distance of order cm. Absorption in the air between the source and the ionization chamber introduces an exponential function of d. When these effects are included, the formula agrees with the data to better than 1%, but the consistency of the results, as indicated by the value of χ^2, is not satisfactory. This is not entirely the result of the errors being larger than estimated, since a much smaller χ^2 was obtained for an arbitrary fitting function (a polynomial in $1/d$). It is therefore concluded that the distance dependence of the exposure rate contains other factors that cannot easily be calculated as a function of distance, for example, secondary sources produced by scattering in the source shielding and collimator. Such scattering may be evaluated theoretically by numerical simulation, using programs such as MCNP or EGS4, or avoided by using a thicker collimator or a completely unshielded source of lower activity.

POSTER 1308

A perturbation based Monte Carlo method for radiotherapy treatment planning

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The use of the Monte Carlo method in radiotherapy treatment planning is desirable for higher orders of calculation accuracy. A method is described that computes dose distributions from in-phantom measurements by considering the perturbations caused by anatomical variation. The calculation uses a Monte Carlo method, the efficiency of which depends on the degree of *a priori* knowledge of

the radiation source and the completeness of the measured dataset. Dose distributions are calculated as a function of the phase space properties of the particle incident on a water phantom. Weighted sums of these distributions are compared with the measured data and adjusted to minimize the difference. A second particle is transported through the patient anatomy in parallel. The ratio of the deposited doses is a perturbation function that can be applied to the measured data and improves in accuracy with each new history. In this implementation, a correlated sampling technique has been used so the transportation of a second particle begins when the patient geometry differs from the phantom geometry. The anatomical structures are defined as faceted surfaces as opposed to a voxel array. Monte Carlo transport of particles through regions of constant density is rapid and regions of varying density and tissue type are properly delineated. Calculations performed with reasonable prior information of the beam rapidly converge to the measured data and to the *in vivo* dose distribution even if the information provided is of poor resolution.

POSTER 1309
Low dose radiotherapy of stage I seminoma — 3.5 years' results

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PURPOSE: We tried to find out whether a reduction of total dose and target volume affects prognosis of patients with stage I seminoma. Patients and methods: 127 patients were irradiated postoperatively. During 1983-1987, 15 patients (group 1) received a total dose of 30 Gy over 4 weeks (single dose 1.5 Gy); target volume: paraaortic (p), iliac (il) or inginal (ing) lymph nodes (12 patients) or p+il (3 patients). From 1988 to 1991, 58 patients (group 2) were administered a total dose of 25.5 Gy over 3.5 weeks (single dose 1.5 Gy); target volume: p+il+ing (11 patients), p+il (20 patients), p (27 patients). From 1992, total dose was reduced to 20 Gy over 2 weeks (single dose 2 Gy, 54 patients, group 3). Target volume: paraaortic lymph nodes. RESULTS: Mean follow-up was 12.5, 7.9 and 3.2 years, respectively. Three patients developed lymph node metastases outside the target volume, three others developed distant metastases. Overall survival was 100% in group 1, and 95% in groups 2 and 3 (ns). Disease-free survival was 100% in group 1 and 97% in groups 2 and 3 (ns). Nausea was present in one patient (group 1), 13 patients (group 2) and 31 patients (group 3), the differences were not significant. CONCLUSION: From our data we conclude that simultaneous reduction of total dose and target volume does not alter prognosis of stage I seminoma patients whereas there is a trend to more frequent nausea which seems to be easily tolerable.

POSTER 1310
Commissioning the Varian enhanced dynamic wedge facility on Helax-TMS

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The enhanced dynamic wedge (EDW) facility on Varian linear accelerators has been in clinical use at this centre for 2 years. Owing to restrictions on the treatment planning facilities available during this period, the EDW was only released for clinical use using symmetric beams. In February 1998, a new 3D treatment planning system, the Helax-TMS, was acquired. The TMS has the ability to calculate dose distributions for symmetric and asymmetric EDW beams. This work describes our experience in commissioning the TMS EDW facility with particular attention to asymmetric beams. To evaluate relative accuracy parallel and perpendicular to the wedge, TMS generated EDW beam profiles were compared with profiles measured in a PTW MP3 water phantom with a linear ion chamber array (LA48), across the range of seven available wedge angles. Absolute dose measurements were performed using a small volume air ionization chamber, again in a water phantom. More realistic dose checks were carried out using IPSM and Rando phantoms. It is shown that the agreement between measured and calculated data is better than 2% over the range of conditions investigated. The problem of independently checking EDW beam monitor units is discussed and a solution is proposed.

Vascular & Interventional Radiology

POSTER 1201
Unusual inferior vena cava anomaly complexes: explanation of the morphology in CT images taking into account embryogenesis

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PURPOSE: Anomalies of the inferior vena cava (IVC) are rare vascular variants, mostly involving the infrarenal segment, and are found with an incidence of between 0.2% and 11% depending on the type of anomaly. Morphological patterns of unusual IVC anomalies in the CT will be explained schematically taking into account embryogenesis. MaterialS and method: An abdominal CT (contrast medium enhanced spiral CT, Elscint CT twin flash, 100 ml Ultravist 300 iv, delay 40 s, 8/8.8; enteral gastrointestinal contrasting) was performed on 656 patients with various different indications. After the CT images had been rendered anonymous, two investigators reviewed them for the presence of IVC anomalies. These anomalies were systematized taking into account embryogenesis and differentiated from lymphomas. RESULTS: Known forms of IVC anomaly were found in a total of 69/656 cases (10.5%). These were distributed as follows: circumaortal venous ring 42/656 (6.4%), retroaortal renal vein 23/656 (3.5%), cava duplication 3/656 (0.5%), and one patient with a left ascending IVC (0.2%). In addition, two unusual anomaly complexes of the IVC were found: (a) an intrahepatic and infrahepatic IVC agenesis with azygos continuation accompanied by duplication of the post-renal segment; (b) an ipsilateral duplication of the IVC and the right common iliac vein. All of the IVC anomalies could be allocated to an embryological development stage. They were successfully differentiated from lymphoma structures in all cases. CONCLUSION: Anomalies of the large retroperitoneal veins can be reliably detected in up to 11% of the cases using CT. The CT enables a sufficient description of the dominant vascular variety and its differentiation from lymphomas, whereby a knowledge of the normal embryological variants is extremely helpful. It is thus possible to detect clearly even unusual IVC anomalies using CT.

POSTER 1202
The drain has "fallen out" — does it matter?

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Image-guided insertion of drains into fluid collections has become part of everyday radiological practice. In order to assess the efficacy of this intervention we performed a prospective study of 122 consecutive drains inserted over a 3 month period. METHODS: No attempt was made to alter the current practice of the individual radiologist in this large teaching hospital with geographically separate ultrasound, CT and fluoroscopy suites. A variety of drains and fixation devices were used. Drains were inserted with a curative intent, for symptomatic control, and prior to a more permanent procedure. RESULTS: Of the 122 drains inserted into 83 patients, 95 were electively removed. 27 drains "fell out" in 23 patients, but only eight of these drains in six patients required re-insertion. The remaining 19 drains which had "fallen out" of 17 patients had clearly served their purpose. In 76 out of 82 patients (93%) the primary objective had been achieved. CONCLUSION: We conclude that the current techniques using a variety of catheters and fixation devices are resulting in good clinical outcome. The first drain inserted is achieving its objective in the vast majority of patients and there is only a small minority in whom the drains "have fallen out" and who require further intervention.

POSTER 1203
Image-guided central venous catheter placement for apheresis in allogeneic stem cell donors

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PURPOSE: Peripheral blood stem cell (PBSC) harvest by apheresis is an increasingly important procedure utilized in the treatment of many malignancies. Whether autologous or allogeneic it is frequently performed via peripheral access because of concern over major complications associated with CVC placement. This study

was to determine for the first time the safety and success, complications and premature failure rates for radiologically placed ultrasound-guided non-tunnelled central venous catheters placed for apheresis in a donor population. MATERIALS AND METHODS: 100 healthy donors were referred for CVC placement for apheresis. Procedural success and complications relating to placement were noted in all. In 97 (97%) cases the number of needle passes required for venous cannulation and whether this was achieved with a single wall puncture was noted. Duration of catherization and reason for removal were recorded in all cases. RESULTS: All catheters were placed by a right transjugular route. Venous cannulation and functioning line placement was achieved in every case (100%). 95 (95%) required only a single needle pass and 87 (87%) only a single wall puncture. There were no placement related complications. 94 (94%) catheters were removed the same day with the remainder removed within 48 h. All completed apheresis. There were no cases of catheter-related infection and no thrombotic complications. CONCLUSION: Our study demonstrates the safe use of central venous catheters for apheresis if ultrasound guidance is used for the puncture and guidewire and catheter position confirmed fluoroscopically and the duration of catheterization is short. In particular, if radiologically placed, CVCs can be safely advocated for all apheresis candidates including allogeneic stem cell donors.

POSTER 1204

Radiologically placed central venous catheters for apheresis

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PURPOSE: Apheresis is an increasingly important procedure in the treatment of a variety of conditions, frequently performed via peripheral access because of concern over major complications associated with central venous catheter (CVC) placement. This study was to determine success, complication and premature failure rates for radiologically placed ultrasound-guided non-tunnelled CVCs placed for aphersis. MATERIALS AND METHODS: 327 patients were referred for CVC placement. Complications relating to placement were noted in all, and in 312 (95%) cases the number of passes required for venepuncture and whether a single wall puncture achieved. Duration of catheterization and reason for removal were recorded in all. RESULTS: Lines were successfully placed in 325/327 (99%). 316 lines were placed in the internal jugular and nine in the femoral vein. 88% required only a single pass and 81% with only anterior wall puncture. Placement complications occurred in six cases (2%), all arterial puncture. In no case did this prevent line placement or have any clinical sequelae. 247 (89%) catheters were removed the same day. Only six catheters were removed prematurely (2%), three because of clotting and three because of suspected infection. CONCLUSION: Our study demonstrates the safety of central venous catheters for apheresis if ultrasound guidance is used for the puncture and fluroscopy is used for guidewire and catheter positioning. Our results show the lowest published procedure related complication rate and the lowest catheter failure rate.

POSTER 1205

3-Scape™ real-time 3D ultrasound imaging

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PURPOSE: Since ultrasound became a real-time modality, it has been difficult to get acceptance for new applications which are not real-time. This has been one of the major obstacles for 3D imaging. 3-Scape™ gives for the first time a real-time feedback of a 3D freehand scan by simultaneously displaying the live 2D image and the sagittal view extracted from the volume being acquired. MATERIALS AND METHODS: Using standard probes, the user can acquire freehand a B mode and Power mode volume. The acquired images are processed in real-time in order to estimate their spatial position, build a volume and display reconstructed images during the scan. A multimedia image processor provides sufficient processing power to estimate the relative x-y motion between images via image-based position sensing techniques. The volume is built incrementally using trilinear interpolation to create a high resolution 3D dataset. This volume can then be visualized interactively via arbitrary slicing and volume rendering. RESULTS: The freehand 3D solution allows the usage of virtually any transducer including multidimensional arrays. The integration into the ultrasound scanner provides flexibility for post-acquisition subtraction of the power mode while retaining the full B mode information. The real-time feedback alerts the user to the quality of his scan. CONCLUSION: 3-Scape™ provides a clinical 3D solution fully integrated into a premium ultrasound system. The high resolution 3D images give access to views not achievable with 2D and help to interpret the anatomy and pathological relationship.

POSTER 1206

Technical note: a low cost technique for vessel sizing in angioplasty

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Vessel measurement in angiography is important for balloon and stent sizing. The most accurate techniques involve calibrating the angiographic image with a catheter with radioopaque markers, but these are expensive. A new method of vessel sizing for angioplasty and stenting is described – the guidewire is moved within the vessel through a set distance, and this movement is shown by digital subtraction. Testing with phantoms shows this to be simple, accurate and reproducible.

POSTER 1207

CT curved linear reformatting: a technique to size abdominal aortic aneurysms before stent grafting

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PURPOSE: To assess the usefulness of curved linear reformats (CLRs) following processing of CT angiography in the sizing of abdominal aortic aneurysms (AAAs) prior to stenting. MATERIALS AND METHODS: Six patients (5 male, mean age 61 years) with AAAs were assessed prior to endovascular stent graft treatment with aortography using a measurement catheter and contrast enhanced helical CT (Philips Tomoscan SR 7000). The CT data were processed on a Philips Easy Vision workstation using Tracker Path software. The central point of the aortic lumen was determined manually using simultaneous axial, coronal and sagittal CT projections at multiple points along the length of the vessel to obtain a CLR through the central axis of the aorta. The lengths of the aneurysm and aneurysm neck below the renal arteries were measured along this axis, and aortic diameters measured in a plane perpendicular to the axis. These measurements were compared with those obtained by the standard technique using aortography and CT before reformatting. RESULTS: Using the CLR technique, vessel diameter measurements were consistently less and aneurysm length measurements consistently greater compared with the standard technique. The discrepancy was up to 1.9 cm for aneurysm length and 2 mm for vessel diameter. CONCLUSION: Standard CT and aortography may underestimate aneurysm length and overestimate vessel diameter. Curved linear reformatting of CT data may size abdominal aortic aneurysms more accurately than standard techniques prior to stent grafting.

POSTER 1208

The value of spiral CT angiography following deployment of endovascular stent grafts for abdominal aortic aneurysms

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PURPOSE: To demonstrate the utility of spiral CT angiography (CTA) in the early detection and assessment of complications following deployment of endovascular stent grafts for management of abdominal aortic aneurysms (AAA). MATERIALS AND METHODS: 16 patients (13 male, 3 female, average age 65 years, range 52–84 years) with abdominal aortic aneurysms treated with endovascular stent grafts were followed up by CTA. All patients had an early (4–7 days) post-deployment scan and the majority (14/16) had a later scan at 6–8 weeks. Two patients had repeat scans at 4 months and 1 year. A single volume acquisition was obtained from the SMA origin to the distal end of the endograft (250 mA, 120 kV, FOV 300, 3/5/2 mm). 100 ml of iopromide 300 mgI ml^{-1} was injected via an 18 G cannula in the antecubital vein at 3 ml s^{-1} using an infusion pump with a scanning delay of 20 s. The axial data were reviewed, together with MPR and MIP reconstructions as necessary. RESULTS: An accurate assessment of stent deployment, particularly with respect to position of the proximal end in relation to the renal artery origins, was possible in all patients. Other features accurately established included graft patency, exclusion of the aneurysm, together with the detection of complications such as perigraft endoleaks, retrograde filling of patent lumbar arteries and graft infection. CONCLUSION: CTA is a safe and relatively non-invasive method for the accurate assessment of endografts in the early period following deployment, particularly for detection of complications.

POSTER 1209

An experimental study comparing mechanical and phased array intravascular ultrasound

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PURPOSE: This study was performed to compare the accuracy of diameter and area measurements and radial geometry accuracy in two mechanical (CVIS and Du-Med) and one phased array (Endosonic) intravascular ultrasound (IVUS) systems. MATERIALS AND METHODS: Lumen quantification in phantoms (Lumen diameter 2.7–4.0 mm) was performed using nine different catheters: two 30 Mhz 3.5 F, one 20 MHz, 8 F, one 32.5 MHz, 4.1 F and five phased array 20 MHz catheters. The influence of ultrasound frequency and catheter to catheter variation was determined. RESULTS: There was a near constant deviation of the measured diameter from the true luminal diameter of -0.75 to ± 0.1 mm. The mean deviation from true diameter was -0.05 ± -0.03 mm with one 30 MHz catheter, -0.03 ± -0.036 mm with another 30 MHz catheter, $+0.09 \pm 0.025$ mm with 20 MHz catheter, -0.54 ± 0.13 with 32.5 MHz catheter, and -0.45 ± -0.09 mm, -0.4 ± 0.13 mm, -0.35 ± 0.11 mm, -0.45 ± 0.13 mm, -0.4 ± 0.11 mm with the five phased array catheters. The maximum distance between holes (1.3 mm) was seen with the 32.5 MHz catheter (Du-Med system). The percent diameter and area deviation was less with mechanical systems. CONCLUSIONS: Luminal diameter and area measurements were underestimated less with small phased array catheters (8% and 14%, respectively) than mechanical systems (16% and 24%, respectively). Large sized and low frequency catheters constantly overestimate diameter and area measurements (2% and 5%, respectively). Catheter to catheter variation was insignificant.

POSTER 1210

Use of a portable thrombolytic analyser system in a radiology department

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PURPOSE: To evaluate the use of the portable thrombolytic analyser system (TAS) during interventional radiology procedures as an alternative to laboratory studies. MATERIALS AND METHODS: 20 controls and 60 patients were studied. The APTT and PT were measured using the TAS analyser and the results compared with conventional laboratory studies. A time and motion survey was conducted over 1 month to assess the impact of the near patient testing on staff utilization and delays to the patient. RESULTS: TAS results were compatible with the laboratory for PT throughout the tested range. The APTT was accurate up to 80 s. The use of the TAS analyser saved a total of 56 manhours in the month studied and avoided cancellation of three patients in whom INR had not been performed. CONCLUSION: The TAS procedure is accurate for measuring APTT and PT in the therapeutic range. Time savings are considerable compared with transportation of samples to the laboratory during procedures.

POSTER 1211

Palliative transcatheter haemoembolization in the treatment of hepatic carcinoma

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The authors report their experience with chemoembolization (CE) as a form of palliation in the treatment of unresectable hepatocellular carcinoma (HCC). The procedure was applied in 19 patients. 13 patients received chemoembolic therapy more than once. 38 treatments were performed in all. The stages were defined according to Occuda's method. The majority of the tumours (14) were classified as stage I. Liver cirrhosis was present in 17 patients, and abnormal levels of alpha fetoproteins were found in 68% of cases. The initial diagnosis was established by echotomography and laboratory studies, while Doppler sonography, CT and angiography were used for staging. The catheter was placed transfemorally in order to introduce a mixture of lipiodol and chemotherapeutic agents into the hepatica propria artery and its branches. CT demonstrated a neoplasm necrosis in 90%, while alpha lipoprotein values were reduced in all. All patients survived 3 and 6 months, and 68% survived a year. There were no fatal outcomes during the procedure, and the overall morbidity rate was 19%. The effects of the relatively safe procedure probably improve both survival and quality of life, particularly if proper patient selection was carried out.

POSTER 1212

Trends in interventional radiology: implications for future work patterns

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PURPOSE: The workload in interventional radiology increases steadily. To cope with this growth, changes in work patterns will be necessary, as well as increases in manpower. The changes in work patterns were studied in a major teaching hospital. METHOD: Data analysis of a prospective and comprehensive interventional database spanning two comparable 6 month periods. All cases were carried in one dedicated interventional room. RESULTS: There was a 26% increase in the total number of cases (111 *vs* 140 cases). Increase was noted in all categories of work (biliary and urological cases such as stenting or draining, central venous access and management and oesophageal stenting and dilation). Although the majority of the work remained in-patient, a significant proportion of the increase was accommodated by increased out-patient intervention, such as in cases of oesophageal intervention, central venous intervention and selected cases of ureteric stenting. Over this period out-patient intervention increased by 50%. CONCLUSION: The increasing workload in interventional radiology in this hospital has led to an expansion in out-patient interventional activity. Our experience and its implications on nursing staffing, sedation and monitoring policies and departmental layout will be discussed.

Notes

National Indoor Arena

Exhibit 01
A PC based CT/MR image registration system for radiotherapy treatment planning
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The exhibit will consist of a PC based system for CT/MR image registration applications in radiotherapy treatment planning. The system is being developed by the Regional Medical Physics Department (RMPD) at Newcastle General Hospital in collaboration with Foster Findlay Associates Ltd (FFA). Image registration is achieved using either matching of operator selected corresponding anatomical points or using an algorithm, based on the mutual information between two images, developed by the Computational Image Science Group at Guy's Hospital, London. The latter method requires little or no user intervention. The software consists of modules developed by RMPD and FFA to be compatible with an image visualization graphical development package (AVS/Express) allowing new functionality and customized user interfaces to be implemented relatively easily and rapidly. The exhibit will demonstrate both the radiotherapy image registration and tumour volume defining applications and show the mechanisms by which new applications can be developed from the existing software.

Exhibit 02
Software for quality assurance and radiation protection
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Two software products will be presented, developed to help the quality assurance processes in the Medical Physics Department of Bradford Royal Infirmary, a busy District Hospital. One of the applications is aimed at efficiently recording and subsequently tracking the progress of job requests which are usually (but not always) phoned in. The software features a user-friendly interface to a database containing lists of current jobs, clients, staff members, equipment and messages. It allows staff to book the equipment required for a job, to record periods of leave, to withdraw equipment from service and to record telephone messages in a simple, fast, easy-to-use way. When equipment is due for calibration or service, the system manager is alerted. The manager can also design and implement complete sets of jobs, *e.g.* a district survey of X-ray equipment. Performance statistics can be extracted in tabular form for all jobs, or viewed by client, staff member and/or over a period of time. Printed reports can be produced. The other application is for quality assurance in the calibration of X-ray equipment. A database contains information about all the equipment which is to be examined, including user-defined sets of questions for the visual inspection, and "templates" for the sets of measurements and tests to be performed. Once these data have been entered, the user can retrieve it for every session. The program can control and interrogate the Keithley Triad dosimeter system and read the results in real-time from the dosimeter. Reports are produced automatically.

Exhibit 03
The Poole approach to objective assessment of digital image quality
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As radiology stumbles toward digital image storage and analysis, there is an increasing need for standardized assessment tools. Ideally, these tools would use universally available phantoms and common PC hardware and software packages. Physics departments are under increasing pressure to reduce the time taken in analysing quality assurance (QA) data on busy imaging equipment and there is a need for greater objectivity. Offline working has proved extremely difficult in the past owing to the vast range of incompatible propriety data storage media. With the widespread adoption of the DICOM 3 protocol for medical image storage and retrieval it is now much easier to read image data. We have developed a software solution to enable data transfer through the hospital LAN, of image data from our CT and MR scanners to a remote PC. This software was written in Visual Basic, using Dicom Objects as the method of data retrieval. In addition, we have developed a package of tools written in MATLAB, enabling us to perform image analysis on MR images based on the eurospin test object set. At present, the software is able to measure signal-to-noise ratio, uniformity, slice width, geometrical distortion and resolution. The results have been compared with those obtained previously using the scanner's own test software with encouraging results. The advantages of this strategy include objectivity of analysis and the ability to compare easily image quality between centres. By using a modular approach to image analysis, we envisage being able to use many of the software components to analyse images from different modalities in the near future.

Exhibit 04
CAMRA — Cardiac Magnetic Resonance Image Analysis
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The accurate and reproducible measurement of cardiac function is essential for monitoring disease progression and responses to therapy. MRI is a non-invasive technology for medical imaging which does not use ionizing radiation. Recently, there have been considerable developments in MRI methods for four-dimensional (three spatial and one time) imaging of the heart with high contrast and spatial resolution. Such techniques can generate in excess of 500 images. The clinical use of such scans has so far been limited to qualitative assessment since affordable software tools were not available to analyse effectively the very large number of images which can be recorded. The processing needs to take place quickly, ideally while the patient is still in the scanner, so that sub-optimal images can be immediately reacquired. The CAMRA software uses high performance computing technology running on a multiprocessor NT workstation, making it significantly more cost effective than existing analysis systems. CAMRA is also independent of the make of scanner. Its aim is to provide semi-automatic image analysis and in particular to provide quantitative measurements of left ventricular (LV) function throughout the cardiac cycle as well as measuring LV stroke volume, muscle mass, wall thickening and wall motion. CAMRA was developed with EC funding in a collaboration between EPCC (University of Edinburgh), Department of Radiology (University of Cambridge and Addenbrooke's Hospital), Department of Cardiac Imaging (University of Leeds and Leeds Teaching Hospital) and Department of Diagnostic Radiology (University Central Hospital of Turku, Finland).

Exhibit 05
Cruise telemedicine using high security Internet transmission of X-ray images and associated medical data
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Two key factors preventing the widespread adoption of telemedicine in maritime healthcare are: (1) the limited availability and high cost of video image transmission over satellite links, and (2) the difficulties with arranging medical experts to be available at the time of setting up the video conference link. We present a new system which allows medical images (*e.g.* X-rays) and any associated clinical data to be sent to land-based medical specialists using medium bandwidth satellite transmission coupled to a secure Internet synchronous or asynchronous data store and forward service. Image capture (*e.g.* X-ray film scanner) and medical data entry are performed on the ship or other marine platform using Microsoft Windows (TM) compatible software (Axcess Healthcare TM, Integrated Dynamics, Cambridge, UK) and a PC compatible computer. The data is encrypted and transmitted using a satellite modem to a secure terrestrial Internet data server (MedServe.com). The server is accessed by the medical specialist via any Internet service provider (ISP) using Axcess Healthcare reporting software which provides authorized users the ability to download and decode the imaging requests. Reports are entered, encrypted and transmitted back to the requesting site by secure e-mail. We report on the results of use of the Axcess system in cruise liner telemedicine and discuss the potential for wider adoption of this service in a variety of marine medical applications.

Exhibit 06
The digital film viewer: an innovative technology
D Inbar
V P Research & Development, SmartLight Ltd, 47 Hataasiya Street, Nesher 20300, Israel
Learn why visual perception is compromised by a conventional light box. See how computer-controlled, EC guidelines-compliant optimization of film viewing conditions improves detection of small, low contrast lesions. Quantitatively measure the improvement in your lesion detectability using a digital film viewer compared with a conventional light box. The diagnostic imaging chain is unbalanced. Optimization efforts have mainly focused on image acquisition and

substantially neglected the final link in the chain, where the radiologist views the film and renders a diagnosis. Conventional light boxes do not adhere to the psychophysical principles of human vision and consequently wash out 25–65% of the grey scale information recorded on the film. Incorporating innovative, adaptive optronic technology to optimize film viewing conditions in accordance with the psychophysical principles of visual perception, the digital film viewer (DFV) significantly extends film latitude and improves the detectability of small, low contrast lesions. Viewing conditions are optimized by automatic seamless masking, control of light intensity and directionality, suppression of film scatter, and control of pupil diameter. DFV technology improves diagnostic quality and automatically complies with European guidelines, German DIN and US MQSA. Participants will make a hands-on comparison between a traditional light box and the DFV, using a contrast detail phantom film.

Exhibit 07

Developments in surgical planning, study visualization and teleradiology

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This exhibit demonstrates the wide range of imaging, radiological and surgical software being developed in our department for Medlab running on Windows 95/98 or NT. Medlab is a rapid medical application development environment which provides numerous technologies including volume, surface and MPR rendering, offline DICOM and SCU support, and Generic File Support. A Number of Medlab modules will be demonstrated. SURGICAL PLANNING AND EVALUATION: Software used routinely in the John Radcliffe Hospital as part of the surgical planning process, including the creation of 5-axis milled models will be demonstrated. Our experience with using this software in a clinical environment has led us to develop real-time material modelling software based on a Simploid volume representation and finite element material modelling for surgical planning and evaluation. This software will be demonstrated and will also be presented by the author as a proffered paper (see p. 9). VISUALIZATION: Our department has been developing advanced case viewing techniques, utilizing virtual reality headsets and stereoscopic shutter glasses. We are evaluating these techniques along with traditional volume and surface rendering with some interesting results; demonstrations will be available at the stand. TELETECHNOLOGIES: Other technologies that are in development and at experimental stages will be demonstrated, these include teleradiology, remote viewing and shared virtual lightbox sessions.

Exhibit 08

A demonstration of multimodal PC based telematic solutions

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Telemedicine systems based on a computer platform are being introduced and evaluated across a wide range of clinical applications, raising ethical and service provision issues for all health providers. Aside from issues regarding the efficacy of methods adopted and their acceptability to patients, financial implications are important. If telemedicine and telehealth systems were to become commonplace, major issues would arise regarding the compatibility of equipment, the cost of computer platforms and data connection systems used and the flexibility required of such systems in order that they operate in a multimodal fashion. Many telemedicine systems tend to operate in a single modality mode, *e.g.* radiology, dermatology, opthalmology, and although this may be acceptable for specialist units within specific hospital departments, primary healthcare professionals need a single workstation, which can be used for a number of different applications. Duplication of resources and the financial implications of adopting bespoke, non-standard, single modality telemedicine technology systems could prove fatal to most plans for widespread telemedicine or telehealth projects. Our exhibit will demonstrate that multimodal operations based on a "low cost" PC platform are possible and financially viable for primary health or hospital based clinicians and other health professionals today.

Exhibit 09

Digital ultrasound capture — the Swansea experience

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It is generally agreed that records of ultrasound examinations should be obtained for both clinical and medico-legal reasons. These records normally consist of radiographic film, the images having been acquired from the ultrasound machine's video signal by either analogue or digital means. This method has considerable resource implications in film, personnel and storage, so an alternative was developed. The new method is essentially a "Mini-PACS" for ultrasound, and whilst the image is still acquired from the ultrasound machine's video signal, it is digitized on a PC using a standard domestic video capture card. Appropriate patient demographics are obtained from the hospital's patient administration system, and are added to the image to produce DICOM images. These are then transferred to a single DICOM server, which stores the images from all the ultrasound machines. The images on the server are held online for a year, and are available either through specialized DICOM viewing software or through a DICOM to http (web) gateway. They are also copied onto CDROM, in DICOM offline storage format, both for security and long-term storage. The system has been in use for 8 months, is well accepted by clinicians, and is saving approximately £2000 per month in film costs, recouping the capital outlay within a year. In addition, it provides the opportunity easily to capture colour images, and the possibility of limited video sequences is being explored.

Exhibit 10

Patient Radiology Information Services — an online information source for the public about diagnostic radiology

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In mid 1988 there was no UK based Internet forum aimed at members of the public concerning diagnostic radiological procedures. In fact, there was only one site, created by the University of Iowa Medical School, that gave any such "patient-directed" information. This site proved to be jargonistic and provided brief information about a very limited number of procedures. We have therefore designed a Web site tailored specifically to the needs of a member of the public be they a patient or merely an interested party. It provides moderately detailed information about most radiological procedures from the simple chest X-ray to MRI angiography and nuclear medicine. The site is spread over 11 pages linked together by both navigation bars and internal hyperlinks. It comprises an introductory home page where the terms radiology, diagnostic imaging, radiologist and radiographer are explained. Pages on each of plain films, fluoroscopy, CT, MRI, ultrasound, barium examinations and nuclear medicine follow. On each page a non-technical explanation of the theory behind the relevant imaging modality is supplied. Then come details of how a test is performed and what the patient should reasonably expect to experience. Alternatively, the inquisitor can go directly to the "A to Z" page where each investigation is listed alphabetically with an accompanying paragraph of explanatory text. The final pages supply information concerning radiology safety issues surrounding dosimetry, contrast agents and pregnancy. A disclaimer concludes the site. The site went online in September 1998 and is currently being revised to include more graphics and links to sites of allied interest and information.

Exhibit 11

CiRiS — Continuous Improvement in Radiology Imaging Services (software)

P Torrie
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A working model of the CiRiS software will be demonstrated. It will incorporate the outcomes of a 6 month pilot in 14 National Health Service (NHS) sites. CiRiS is a unique approach to encouraging continuous improvement in radiological clinical services and is particularly adapted to meet the requirements of clinical governance and objective quality measures being devised by the Department of Health.

Exhibit 12

Extending an existing multimedia delivered radiography Master's programme, to allow global delivery using Internet based resources

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The authors of a 1997 exhibit presented a demonstration of the use of multimedia authoring package to generate a full Master's programme for radiography education. Principally delivered via multimedia presentations on CDROM, the programme has now run for 2 years and significant student feedback has been received. This has resulted in work revising the distribution to provide an Internet based delivery platform for the programme. The Internet enhances

programme delivery in three ways: instant and open access is available, it is platform independent allowing usage of standard Web browsers for access, and the content can be instantly updated. Additional advantages include e-mail, student conferences and the submission of information back to St Martin's, through self-evaluation exercises and coursework. The use of online interactive chat facilities and links to allow searching and access to imaging libraries are also included. The Internet plays an increasing role in the delivery of distance learning course and materials The authors believe that this role will continue to develop, and that the potential that it offers should be utilized. The display will provide demonstrable online access to a range of currently developed Internet based programme material. It will also include details of how the Web based material was developed and the technical hardware/software required. A major feature of the exhibit will address the challenge of providing text, pictures, sound and video within the current bandwidth limitations associated with the Internet.

Exhibit 13
Multimedia radiology teaching using Macromedia Authorware 4

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Macromedia Authorware 4® is a program that allows the design and construction of interactive multimedia presentations. We have used it to produce radiology teaching files, based on diagnostic images, video material and textual information. Users of these files are able to view images, with and without annotation, as well as relevant clinical information, diagnosis and background information. In addition, interactive text based self-test sections are included related to the case in question. The finished teaching files may be viewed using either a PC or a Macintosh system. Distribution of teaching cases thus produced is possible in disk format, *e.g.* Zip or CD-ROM, or by inclusion in a Web page structure, such as departmental Intranet or the Internet itself. Traditionally, Internet based teaching files of this nature have been hampered by long download times. Authorware addresses this problem in two ways. Firstly, by breaking down a piece into separate segments, which are downloaded sequentially, viewing the piece can be started before all the elements are available. Secondly, certain sections of a piece, *e.g.* Clinical Information, will only be downloaded if specifically requested by the viewer, further decreasing overall download times.

Exhibit 14
The establishment of a new radiographic and medical imaging resource on the World Wide Web

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Efforts to document the establishment of a new imaging and radiographic resource Web site are described at the Web site www.radiographers.com on the Internet which went live on 1 April 1999. The impetus for the establishment of this new development on the World Wide Web is to provide a valuable and relevant resource for radiographers, students and allied professions which is created by radiographers and other professional colleagues with a strong interest in this area. Topics will reflect ongoing concerns within this rapidly evolving profession. Specifically they will include items germane to those interested in continuing professional development (CPD) within medical imaging. These topics will include the following: *A useful point of reference for background technical articles relevant to the practice of modern medical imaging. *A range of more in-depth descriptions and discussions of new technology and science necessary for a fuller understanding of the practice of radiography and closely related disciplines. *A wide range of pointers to other useful sites that medical professionals will find both useful and interesting. *A section or discussion area to deal with relevant communications from those interested in or currently practising within medical imaging. *Advice on courses for pre and postgraduate students. *An editorial comment area for invited speakers. Commercial sponsorship of the site will be welcomed in order to cover the ongoing costs associated with site purchase and maintenance, but will not be allowed to become intrusive. It is intended to run the site initially with a no-profit ethic. Further information from: Garry Mahn ⟨garry@radiographers.com⟩, Peter Ryan ⟨peter@radiographers.com⟩ or Mike Tatlow ⟨mike@radiographers.com⟩.

Exhibit 15
ECTMUS — Education and Clinical Training in Medical UltraSound

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The ECTMUS project is a European Commission funded programme examining the delivery of clinical ultrasound education by open and distance learning. The programme is a collaboration between the MBRT based at the Hogeschool Haarlem, De Open Universiteit of the Netherlands, and clinical partners in Plymouth, UK, Amsterdam NL, Oporto, Coimbra and Faro Pt, with associates at the University of Malta. The programme involves the use of CDROM, computer-mediated conferencing (CMC) videotapes and traditional printed material. One additional educational process is also employed, that of problem basedlearning. It has been long recognised that any higher level degree requires learners to develop higher cognitive and analytical skills. Problem based learning allows for the collaboration and discussion of topics. The use of CMC provides a forum for this collaboration to happen. The application chosen for the project CMC was Lotus Notes. The students are provided with what was then high specification laptops, which enabled the development team to create courseware and use proprietary CMC software. This was to investigate the use of Information and Communication Technologies (ICT). The students performed the problem-based discussion in the Notes CMC, the scenarios and related material being presented in a paper form. The discussion group device has also been used to develop the material, theauthoring and collaboration taking place in a virtual environment, with meetings happening on an "as and when" basis. The remit of the programme was to use a mixed mode delivery problem based approach to investigate the potential of delivering a validated training assessing both academic and clinical competencies. From the five clinical partners, three training scenarios were identified each involving a differing level of clinical supervision, but all involving the same degree of ICT usage. The proposed exhibit will demonstrate the CD-ROM based training material and look at the on-line discussions that the students are participating in. The project is still ongoing and therefore the discussion reviewed will be very current.

Notes

Monday 17 May

1145–1215
Work in Progress
Vascular Imaging and Intervention 1
Hall 11A

1145
Angiography and angioplasty in patients with scleroderma: 5 years experience
E Dick, R Aviv, I Francis, G Hamilton, C Black, A Platts and A Watkinson
Department of Radiology, Royal Free Hospital, Pond Street, London NW3 2PG, UK
OBJECTIVES: (1) To define in which patients with scleroderma radiological intervention is useful; (2) to identify angiographic disease patterns in patients with and without other vascular risk factors; and (3) to assess the usefulness of percutaneous intervention. MATERIALS AND METHODS: Of 1000 patients with scleroderma at our institution, 16 have undergone angiography or angioplasty in the last 5 years. We obtained full angiographic and clinical follow-up on 15 patients. We noted the patients' age, gender and age at diagnosis of scleroderma. The indication for angiography was recorded. Other vascular risk factors (*e.g.* smoking, hypercholesterolaemia) were noted. Upper and lower limb angiograms were assessed blinded to the patients' identity, using modified Brewster classification (Type I–III equals proximal disease, Type IV equals distal disease — below knee or elbow). RESULTS: Five patients with scleroderma (both with and without other vascular risk factors) underwent upper limb angiography, of whom four had distal disease. 11 patients underwent angiography of the lower limb, eight of whom had other vascular risk factors, and had macrovascular disease (Type I–III on the Brewster classification). Three patients without other vascular risk factors had distal or below knee disease. There is a highly significant association between the presence of other vascular risk factors and macrovascular disease, and conversely between the absence of other vascular risk factors and distal disease (Fisher's Exact test, $p=0.006$). In the small group of patients who underwent angioplasty there were good clinical results in 30% of patients. CONCLUSION: It appears that in this small group of patients with scleroderma, angiography was only useful if other vascular risk factors were present.

1155
Assessment of a computerized strain-gauge plethysmograph in patients presenting with clinically suspected deep venous thrombosis
A J P Goddard and S Chakraverty
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Suspected deep venous thrombosis (DVT) is a common problem in clinical practice. The majority of patients attending for radiological investigation do not have identifiable DVT. OBJECTIVE: To assess whether the CSGP (Venometer; Advanced Medical Technology, Belfast) can identify those patients who will have negative ultrasound for proximal thrombus so that radiological investigation is unnecessary. METHODS: Patients underwent examination in the Radiology Department with the Venometer by unqualified staff and Doppler ultrasound by experienced practitioners unaware of the Venometer result. Discordant results were resolved by contrast venography. RESULTS: In the first 3 months of the study, 134 patients presented with possible DVT. 11 were unable to tolerate the Venometer. 88 examinations were negative and 27 positive on both studies. Nine were discordant. There were five false positive results, one false negative and one equivocal (positive on ultrasound) Venometer results. There were two false positive ultrasounds. Detailed analysis and updated numbers will be presented. CONCLUSIONS: The AMT Venometer has a high negative predictive value for proximal DVT. It can be safely used as the sole diagnostic test to allow patients to be discharged with appropriate advice but without further investigation. This saves ward and radiology resources and can be operated on a 24 h basis by trained but unqualified staff. Initial trial of the equipment alongside radiological investigation increases clinicians' confidence and allows appropriate transfer to an A&E department or medical admissions ward.

1205
Discussion

1400–1500
Work in Progress
MR Topics
Hall 8

1400
Incidence of lumbar disc high intensity zone on MRI among young women
G Kawakami, T Sekiya, S Tada, K Fukuda, H Miyazaki, H Okoshi and I Asukata
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PURPOSE: The high intensity zone (HIZ) within the posterior anulus fibrosus on T_2 weighted images has been reported as a reliable sign for low back pain (LBP). However, the prevalence of HIZ in an asymptomatic population is not yet known. The purpose of our study was to examine the incidence of HIZ in ordinary active people and to analyse the correlation between HIZ and LBP. MATERIALS AND METHODS: MRI of the lumber spine was obtained as a part of health check-up in 339 cabin attendants employed by Japan Airlines with a mean age of 23.2 years. Presence or absence of LBP was also ascertained. Incidence of HIZ was analysed by three radiologists independently. Interobserver agreement of the findings was calculated according to the statistical methods proposed by Fleiss. Statistical analysis between HIZ and LBP was performed with χ^2 test and Wilcoxon test. Odds ratio of LBP incidence between HIZ positive and HIZ negative cases was also calculated. RESULTS: Interobserver reliability among radiologists was excellent (correlation coefficient 0.905). HIZ was present in 46 cases (13.6%), 16 of whom had LBP. However, the remaining 30 cases were free of LBP. Significant correlation was present between HIZ and LBP (χ^2 test $p=0.002$ and Wilcoxon test $p=0.007$). Calculated odds ratio showed 3.09 times higher incidence of LBP in HIZ positive than HIZ negative cases. Positive predictive value of HIZ for LBP was 34.8%. CONCLUSION: Although there is significant correlation between HIZ and LBP, positive predictive value of HIZ is not high. Therefore, HIZ could not be regarded as a specific sign of LBP.

1410
MR features of spinal tuberculosis
A Kapoor, V Mondal, S Vashisht, R Sharma, M S Gulati, S B Paul and M Berry
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PURPOSE: To demonstrate the MR spectrum of findings in tubercular spondylitis. MATERIALS AND METHODS: A total of 106 patients (55 males, 51 females) with tuberculous spondylitis underwent MR examination. The diagnosis was based on clinical, laboratory and radiological investigations and subsequently confirmed by biopsy, surgery or response to anti-tubercular therapy. Analysis of lesion location and image morphology revealed a wide spectrum of findings. RESULTS: MR was able to detect early lesions in 10 patients with normal plain radiographs. Vertebral lesions occurred most frequently in the dorsal spine (62) followed by lumbar (26), lumbosacral (10), dorsolumbar (9) cervical (7) and cervicodorsal (5) region (lesions were multifocal in 13 patients). Vertebral body involvement along with posterior element involvement was noted in 67 cases. However, isolated posterior element involvement was seen in only two cases. MR findings included contiguous vertebral involvement, disc space involvement, pre/paravertebral soft tissue extension including anterior subligamentous spread, epidural extension, cord involvement and spinal deformity. The presence of a hyperintense rim around the intraosseous as well as soft tissue lesions on T_1 weighted images was noted in 66 of the 106 patients. This rim corresponds to the area of enchancement following gadolinium administration. This feature has not been described earlier. CONCLUSIONS: A combination of contiguous vertebral involvement, disc space involvement, associated large soft tissue component and rim enhancement following Gd-DTPA strongly suggest the diagnosis of tubercular spondylitis. The hyperintense rim sign described here can serve as a diagnostic feature in the absence of contrast medium administration.

1420
MRI of the pre-term neonate using a dedicated 0.2 T magnet on the SCBU
E H Whitby, M N Paley, M F Smith, K Teasdale, P Greenwood and P D Griffiths
Academic Department of Radiology, University of Sheffield, Sheffield S10 2SF, UK
AIM: To set up a dedicated magnetic resonance (MR) scanner adjacent to the special care baby unit (SCBU) for imaging neonates on site without the need for sedation or anaesthesia. METHODS: A Niche MR scanner 0.2 T field strength, 15 mT m^{-1} gradient strength, using a loop radiofrequency (RF) coil was installed in an area 100 ft^2. Images were obtained in axial and coronal planes. Imaging sequences used depended on the clinical requirements. Spatial resolution was 1 mm in plane, 5 mm slices. Each baby had an ultrasound scan for comparison. Occasionally, a CT was performed. RESULTS: 50 babies have been successfully scanned to date (39 normal and 11 abnormal). The babies were readily accessible throughout the scan. Eight had major pathologies (hydranencephaly, posterior fossa bleed, hypoxic ischaemic encephalopathy, subarachnoid haemorrhage, hydrocepahlus, arachnoid cyst, subdural and cephalohaematoma, severe periventricular leucomalacia). All were accurately detected and the extent of the pathology defined. In seven cases MR provided additional information to both ultrasound and CT. One baby had an abnormal low signal in the left temporal lobe thought to result from parenchymal damage. Two babies had early intraventricular haemorrhages on ultrasound not detected on MR scanning. Further development should allow their detection. Ultrasound and CT did not detect any pathology that had an impact on patient management that was not detected on MR. CONCLUSION: The Niche MR system is safe, convenient and well tolerated by neonates. The information obtained is as good as if not better than that from ultrasound and CT.

WORK in PROGRESS

1430
Perfusion weighted MRI in a normal ageing population
N Hoggard, I Wilkinson and P D Griffiths
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INTRODUCTION: The role of perfusion weighted MRI in the early assessment of acute stroke is being increasingly investigated with little published analysis of normal variation in the population. PURPOSE: To obtain normative data for perfusion weighted MRI. MATERIALS AND METHODS: All individuals were aged over 55 years and had normal MR angiography (MRA) of the neck and intracranial circulation. Data were obtained on a Picker Eclipse 1.5 T scanner using a T_2* weighted EPI sequence (TE 60 ms and TR 1.4 s) with a range of doses of Gd-DPTA from 0.12 ml kg^{-1} up to 0.36 ml kg^{-1}. The time to peak (TTP) in signal change was calculated for the thalamus, putamen, frontal deep white matter, posterior circulation deep white matter, anterior circulation cortical grey matter and compared with the ipsilateral proximal middle cerebral artery (MCA) for each hemisphere. Contrast-to-noise (C/N) ratios were assessed for the thalamus, putamen and frontal deep white matter. RESULTS: The results show symmetry between the hemispheres, the greatest delay being in deep white matter and the least in the basal ganglia. The larger the region of interest the more reproducible the findings. C/N ratios improved with larger doses. There were, however, large variations between individuals. CONCLUSION: There are large interindividual variations but when related to each individual's ipsilateral proximal MCA results are consistent. C/N ratio variation is not simply related to dose. Variation between individuals can outweigh dose related changes but TTP in signal change was always longer in deep white matter than in grey matter.

1440
Effects of MR-related acoustic noise on hearing: otoacoustic emission measurements
P Radomskij, M A Schmidt, D Prasher and C W Heron
Magnetic Resonance Unit and Department of Audiology, St George's Hospital, London SW17 0QT, UK
INTRODUCTION: A direct measurement of the effects of acoustic noise in MRI is relevant not only for patients but also for healthcare professionals. Otoacoustic emissions (OAE) are used clinically to assess cochlear function and detect small changes which may not be reflected in the psychoacoustic hearing threshold. PURPOSE: This study evaluates the effects of exposure to the MR-related acoustic noise on hearing by the assessment of OAE of patients undergoing MRI head examinations. MATERIALS AND METHODS: Patients undergoing MRI for suspected acoustic neuroma were selected for this project provided that they had not been exposed to excessive noise levels over the previous 24 h. OAE measurements were made both before and immediately after the MRI examination, from the normally hearing ear(s). The final OAE measurement was carried out within 15 min of the end of the scan. All MRI patients used earplugs. The reproducibility of the OAE measurements was also tested in a control group not exposed to MRI-related noise. RESULTS: Noise levels in the scanner were estimated to vary between 120 and 140 Lpk SPL (dB). The duration of the MRI examination varied between 24 and 38 min. The group of MRI patients showed reductions in OAE response from 1.5 to 5.5 dB, with the greatest changes in the 1 kHz region. Within the control group, OAE measurements varied by less then ± 1 dB. CONCLUSIONS: There are small but significant changes in cochlear function in patients undergoing routine MRI head scans.

1450
Discussion

1635–1700
Work in Progress
Radiographers: Professional Development
Hall 11A

1635
Over 1000 consecutive barium enema examinations performed by radiographers — quality assured!
J Oommen, S Park, A Blakeborough, S Braithwaite, P Memmott, C Pridmore and M C Collins
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At our institution, radiographers have been performing most/all of the out-patient barium enema examinations for over 3 years. All examinations are reported by one of two consultant radiologists. Since September 1997, a prospective study has been undertaken to assess the diagnostic quality, as judged by the reporting consultant, dividing the large bowel into 5 regions: rectum, sigmoid, left colon, right colon, caecum. Each region is assessed for diagnostic quality using a 4 point scale: 0 = not seen, 1 = poor, 2 = satisfactory, 3 = excellent. To date, analysis of data of over 1000 consecutive examinations show diagnostic quality (grades 2 & 3) achieved in 99%, 97%, 99%, 96% and 96% of cases for the rectum, the sigmoid, the left colon, the right colon and the caecum respectively. These preliminary results support our impression that radiographers routinely perform high quality barium enema examinations. Given the recent interest in screening programmes for colorectal cancer, a potential role exists for radiographers should the barium enema examination be adopted.

1645
Discussion

1700–1730
Work in Progress
Vascular Imaging and Intervention 2
Hall 11B

1700
Contrast enhanced magnetic resonance angiography: a review of clinical referrals in a specialist cardiovascular unit
J M Francis, R H Mohiaddin, J Keegan, P D Gatehouse, J R Panting and D J Pennell
Cardiovascular Magnetic Resonance Unit, Royal Brompton and Harefield NHS Trust, Sydney Street, London SW3 6NP, UK
INTRODUCTION: Contrast enhanced magnetic resonance angiography (CE-MRA) has become popular in the assessment of vascular anatomy in areas of major physiological motion such as the thorax and abdomen. We reviewed the clinical referrals and value of CE-MRA in our specialized cardiovascular unit. METHOD: 60 patients (43 males), mean age 52 years (range 12–82 years) had 64

studies performed over 18 months on a 1.5 T scanner. An initial bolus of 2 ml Gd-DTPA followed by 10 ml of normal saline was given intravenously during simultaneous acquisition of 30–40 two-dimensional gradient echo images at 1 image/s. A volume acquisition was performed during injection of 20–25 ml Gd-DTPA and 20 30 ml saline calculated to arrive at the time of central k-space acquisition minus 10%. Injections were performed using a power injector at 2 ml s^{-1}. Maximum signal intensity projection of the acquired volume was obtained to produce a three-dimensional (3D) angiogram. RESULTS: Indications for CE-MRA were: to delineate thoracic and abdominal aortic aneurysms and visualize branch vessels (31%), to exclude renal artery stenosis before surgical or pharmacological intervention (31%), to exclude carotid or subclavian stenosis (16%), to assess surgical conduits, central pulmonary arteries and aortic coarctation in patients with congenital heart disease (19%) and peripheral vascular disease and inferior vena cava (3%). Initial bolus transit time varied between 5 and 38 s, necessitating careful calculation for each study. Successful 3D CE-MRA was obtained in all cases. CONCLUSION: 3D CE-MRA is a robust, minimally invasive technique providing information regarding vascular morphology in a variety of acquired and congenital cardiovascular disease.

1710

Evaluation of carotid stenosis by ultrasound, MRA, first pass gadolinium enhanced MRA and conventional angiography

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AIMS: (1) To investigate the accuracy of time-of-flight and first pass gadolinium MRA techniques when compared with conventional angiography. (2) To study the possible clinical role of first pass gadolinium enhanced MRA in the assessment of carotid stenosis. MATERIALS AND METHODS: Ultrasound, conventional angiography, time-of-flight and first pass gadolinium enhanced MRA were performed on 22 patients being investigated for suspected carotid stenosis. The ultrasound and conventional angiography measurements were made by experienced radiologists using NASCET guidelines. The MRA data were analysed by measuring the full width at half maximum on lumen intensity profiles of the internal carotid artery (ICA) using the background level as the baseline. These measurements were then compared with those taken from the distal ICA andpercentage stenoses were calculated. RESULTS: 22 patients (44 vessels) have been assessed to date (13 male, 9 female; age range 54–83 years). Using conventional angiography as the gold standard, the 44 vessels showed the following stenoses: normal/mild (0–29%), 14; moderate (30 69%), 5; severe (70 99%), 18; occluded (100%), 7. The most significant findings were: (1) ultrasound underestimated 33% of severe stenoses and 57% of occlusions; (2) time-of-flight MRA underestimated 17% of severe stenoses and 29% of occlusions; (3) gadolinium-enhanced angiography underestimated 17% of severe stenoses but reported all occlusions correctly. CONCLUSIONS: Our data indicate that MRA is an accurate screening tool and compares favourably with ultrasound. They also suggest that MRA has similar accuracy when compared with conventional angiography. The extra information gained from gadolinium enhanced MR is limited, but is useful in distinguishing severely stenosed and occluded vessels.

1720

Evaluation of portal venous system patency, contrast enhanced MRI *versus* FISP

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Dynamic contrast enhanced breath-hold gradient echo sequences have been compared favourably with X-ray angiography in the evaluation of the portal venous system. Fast imaging steady precession (FISP) is an ultrafast heavily weighted T_2 gradient echo sequence which results in bright vessels without the need for contrast. This is a retrospective study of 33 patients who had upper abdominal MRI between June 1997 and October 1998. All examinations included axial and/or coronal gadolinium enhancement gradient echo sequences and FISP images. Patients were scanned on a Siemens magnetom 1.5 tesla scanner using a phase array body coil. The images were scored independently by two radiologists who were blinded to all clinical details and other imaging. Vessels scored included the left, right and main portal vein, splenic vein, superior mesenteric vein and inferior vena cava (IVC). Each vessel was scored as patent, partial or completely thrombosed. There was good correlation between both observers for both imaging sequences. There was also good correlation between the two imaging sequences with the same score obtained in 90% of the vessels evaluated (observer 1) and 81% (observer 2). Flow artefacts were noted in 13 vessels for FISP images and in 35 vessels for gadolinium enhanced images. Both imaging sequences detected thrombus seen within the portal venous system in six of the 33 patients. In conclusion, FISP appears to be a reliable imaging sequence to exclude portal vein thrombus.

Tuesday 18 May

11.15–11.45
Work in Progress
Dose Reduction & Intensifier Performance
Hall 5

1115
Reduction in patient dose by use of a direct-capture digital imaging system
D Richardson, S Barrow and P Colls
Royal Victoria Infirmary, Newcastle on Tyne, UK
PURPOSE: Use of Sterling Direct Ray system to acquire chest radiographs at reduced exposures and assessment of image quality at doses equivalent to 400 and 600 speed systems. METHODS: A prototype of Sterling's photoconductor-based Direct Ray was installed in a general radiographic room. 50 patients each had two chest radiographs performed, the first using an exposure compatible with a 400 speed imaging system, the second with a 600 speed system. Exposure reduction was achieved by the use of added external filtration. The actual entrance skin dose for each examination was measured and recorded. The 50 image pairs were assessed by five consultant radiologists. RESULTS: The management of the trial is described. Dose measurement methods and the means by which dose could be reduced are compared. CONCLUSIONS: Results suggest that there is scope for significant reduction in patient dose without unacceptable increase in image noise. Further development of processing algorithms specifically designed for low exposure images may lead to further reductions.

1125
Geometric calibration of image intensifier images without reference objects
M A Schmidt and A J Britten
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INTRODUCTION: Geometric measurements from image intensifier-based systems are complicated by image distortion and the dependence of the magnification on the distance between object and image intensifier (II). Calibration from a reference object (*e.g.* catheter) is poor since it may not be at the same distance from the II as the object to be measured. However, the magnification of any structures can be calculated if the examination involves known changes in the relative position between the II and the structures of interest. PURPOSE: To measure the size of structures in digital images from II systems using known translation or rotation of the detector. MATERIALS AND METHODS: Images from a 40 cm II digital system (IGE, DLX) were corrected for distortion using a grid reference image. Two types of image intensifier motion were used whilst imaging a test object: table translation in steps of 2.5 cm and changes of obliquity in steps of 15° (from +45° to −45°). The data were processed to assess the accuracy of the technique in calculating the magnification and calibration factor (mm/pixel). RESULTS: The image intensifier-related distortion was corrected with precision of under 0.5 pixels on the grid points. In the table translation protocol (8 images, 25 mm step size) the calibration factor was calculated with 0.25% accuracy. Errors in calculating the known size of test object (20 mm) were of the order or 0.1 mm. CONCLUSIONS: Geometric measurements in II images can be accurately performed without reference objects. This can be directly applied to existing clinical protocols.

1135
Evaluating the entrance dose for hysterosalpingography (HSG) using non-digital and digital equipment
D D Maudgil, I A J Fife, N T Hayat, I Francis, R Aviv and A Watkinson
Department of Radiology, Royal Free Hospital, Pond Street, London NW1, UK
PURPOSE: To audit the entrance dose for HSG using current non-digital equipment (fluoroscopy screening unit with C-arm and Wolverson image intensifier) and to measure any variation following the introduction of digital equipment (Philips digital fluoroscopy screening unit with undercouch tube). METHOD: Each patient gave informed consent for the study. Demographic data were recorded. Entrance dose was measured using thermoluminescent dosemeters (TLDs), placed on the surface to correspond anatomically with each ovary, uterus and cervix. Standard HSG was performed by a radiologist using Omnipaque 240. Number of exposures, kV and mAs were noted. RESULTS: Nine non-digital HSGs have been evaluated so far. The average entrance dose was 3.16 mGy (sd 1.50), with no significant variation between the four sites measured. CONCLUSIONS: The entrance dose measured seems to compare well with previously reported data. We plan to measure entrance doses for 20 more non-digital HSGs and compare these with digital HSGs.

1625–1715
Work in Progress
Dose Reduction & Audit
Hall 11A

1625
Photoconductor-based digital projection radiography — effect of dose reduction on image quality
D Richardson and S Barrow
Royal Victoria Infirmary, Newcastle on Tyne, UK
PURPOSE: Digital radiographic systems do not have a fixed speed. Reducing the exposure to which the detector (and patient) are exposed does not cause a decrease in image density, rather the noise present in the image increases. Dose a dose reduction of 50% result in an unacceptable increase in image noise? METHODS: Using a photoconductor-based Sterling Direct Ray unit, 50 patients had two chest radiographs acquired, at exposures equivalent to 400 and 600 speed imaging systems. The 100 images were assessed by five consultant radiologists. A pre-designed form was used to score images with particular reference to 10 specific anatomical areas. RESULTS: In progress. CONCLUSIONS: If significant dose reduction can be made by use of this digital imaging technology and technique, the saving in an individual chest examination would be small, but the large number of chest examinations performed means that the dose reduction to the population as a whole could be considerable.

1635
Direct staff dose measurement in orthopaedic trauma theatre during DHS procedures
A Maxwell, J A Alonso, D L Shaw, G P McGill and G C Hart
Departments of Medical Physics and Orthopaedics and Trauma, Bradford Royal Infirmary, Bradford BD9 6RJ, UK
PURPOSE: In response to concerns expressed by orthopaedic theatre staff we measured doses received during fluoroscopic screening procedures. We have completed 10 sets of measurements for dynamic hip screw procedures, the most common orthopaedic procedure where the surgeon stands close to the patient during screening. MATERIALS AND METHODS: *In situ* measurements were carried out using Siemens EPD-2 direct reading electronic dosemeters. The dosemeters were clipped to the outside of the lead aprons worn by staff, giving a measurement of the unshielded dose. The dosemeters were worn by the surgeon, assistant, scrub nurse, anaesthetist and radiographer. Empirical measurements were carried out using a dose rate calibrated scintillation monitor. The surgical situation was reproduced in the operating theatre using a scattering phantom. The dose rate distribution in the theatre was mapped for posteroanterior (PA) and lateral projections, and for waist and thyroid height. RESULTS: The average doses recorded by each member of staff for each procedure were as follows: surgeon 13.7 μSv, assistant 11.8 μSv, scrub nurse 1.3 μSv, anaesthetist 0.25 μSv, radiographer 0.4 μSv. The dose–area product was recorded for each procedure. The empirical dose rate measurements were consistent with the *in situ* measurements for the recorded screening time per procedure. CONCLUSION: These measurements show that orthopaedic surgical staff receive a non-trivial radiation dose during procedures which involve fluoroscopy. We are conducting a survey of clinical workload to estimate a yearly dose burden for staff.

1645
Estimation of effective dose from radiographic examination of the ankle
A C Eyden, C D Jeffery and K J Piper
Department of Radiography, Canterbury Christ Church University College, Canterbury CT1 1QU, UK
PURPOSE: Scattered radiation is produced in every radiographic examination and therefore contributes towards effective dose. The aim of this work was physically to measure the scattered radiation doses and utilize these data to gain a greater understanding of the secondary radiation received during extremity examinations, for

example, the ankle. MATERIALS AND METHODS: A silicon semiconductor detector was placed inside a sectional anthropomorphic limbless phantom. Simulated limbs were constructed from bone, water and a radiolucent cast and added to the anthropomorphic phantom. The apparatus was assembled to reproduce an anteroposterior radiographic projection of the ankle. Dose measurements were made using 2500 clinical exposures at 800 predetermined skin, bone and muscle sites throughout the phantom (including limbs). These sites included remaining organs and tissue types stated in the International Commission of Radiological Protection (ICRP) Publication 60 for measurement of effective dose (gonads, lung, thyroid, breast, oesophagus, plus the major abdominal and pelvic organs). RESULTS: The resultant dataset consists of a comprehensive set of organ and tissue dose measurements in the pGy to μGy range for a simulated anteroposterior ankle examination. The experimental set-up and sensitivity of the detection system enabled exploratory investigations to be made which examined the effect of gonad protection. Male and female gonad doses were measured with and without lead protection. Early analysis suggests that significant differences are evident and final results of this work will be presented.

1655

Display of isodose rate curves in an interventional screening room

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Medical Physics Department, Royal Free Hospital, London NW3 2QG, UK

PURPOSE: A very functional way of examining the dose rate distribution over a room containing X-ray equipment is by plotting isodose rate curves. The data for these may be obtained from measurements of air kerma rate from a scattering volume irradiated at typical clinical exposure parameters. The information obtained from the display of the curves can be used as an aid in the application of radiation protection principles. Examples are: (1) designing protective barriers (shielding materials and thicknesses); (2) considering the optimum placement of equipment around the room including radiation protection equipment; (3) determining the best location for essential personnel whilst maintaining clinical efficacy of the examination. METHOD: For this report, an Excel spreadsheet was constructed to display isodose rate curves. The spreadsheet is divided into several worksheets, each one referring to a different angle of measurement. The user inputs their measurements of air kerma rate at different distances and directions from a scattering volume, and the spreadsheet performs calculations extrapolating data at other positions. RESULT: The user can then input a desired isodose rate value and the spreadsheet constructs and displays a family of isodose rate curves. Each point on this plot has a measurement error associated with it. CONCLUSION: This software is simple to use and has many applications in radiation protection. It has proved to be very helpful in a visual interpretation of the environmental dose rates in an interventional room. It facilitates a critical analysis of examination technique in order to reduce staff and patient dose.

1705

Discussion

Wednesday 19 May

0830–0945
Work in Progress
Mammography/Imaging for Oncology
Hall 6

0830

The prediction of pathological breast cancer response to primary chemotherapy using ^{18}F-FDG PET

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PURPOSE: To determine if ^{18}F-FDG PET can predict the pathological response of primary and metastatic breast cancer to chemotherapy. METHODS: Patients with breast cancer destined to receive 8 cycles of chemotherapy prior to surgery are enrolled into this ongoing study. Dynamic PET imaging using 185 MBq of ^{18}F-FDG is performed immediately prior to the first, second and fifth pulses and following the last pulse of chemotherapy. Primary tumours and involved axillary lymph nodes were identified and DUR and K values of ^{18}F-FDG uptake calculated. Pathological response was determined by evaluation of the surgical resection specimens. RESULTS: To date, 24 patients have completed the study. *In primary tumours*: Mean pre-treatment K and DUR values were not significantly different in responding and non-responding lesions (DUR: $p=0.848$; K: $p=0.717$). The mean percentage change in DUR following the first pulse of chemotherapy was significantly greater in responding lesions ($p=0.005$). Using a 15% change in DUR as a cut-off, PET following a single pulse of chemotherapy was able to predict pathological response with a sensitivity of 75% and a specificity of 100%. *In metastatic tumours*: Mean pre-treatment K and DUR values were not significantly different in responding and non-responding lesions (DUR: $p=0.406$; K: $p=0.152$). The mean percentage change in DUR and K following the first pulse of chemotherapy was significantly greater in responding lesions (DUR: $p=0.005$; K: $p=0.019$). CONCLUSIONS: ^{18}F-FDG PET imaging of primary and metastatic breast cancer following a single pulse of chemotherapy may be of value in the prediction of pathological treatment response.

0840

Relationship of MRI and clinical staging to outcome in invasive bladder cancer treated by radiotherapy

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AIM: The aim of this prospective study was to identify features on MRI and clinical staging which were related to early relapse and poor survival in patients with invasive bladder cancer undergoing radiotherapy. PATIENTS AND METHODS: Patients with a cystoscopic diagnosis of invasive bladder cancer who were referred to this hospital underwent MRI of the abdomen and pelvis (1.0 T) prior to radiotherapy. Tumour size, site, degree of infiltration, presence or absence of adenopathy and hydronephrosis were all assessed and an appropriate radiological stage assigned to each patient. All patients were on regular cystoscopic follow-up post-radiotherapy. Date of first relapse and date of death were recorded. RESULTS: Between 1993 and 1997, 143 patients (111 male, 32 female) were examined. The median age was 60.7 years and the median follow-up was 2.8 years for survivors. The most notable feature on pre-treatment imaging was the increased number of patients assigned to stage T3 by MRI ($n=91$ *vs* $n=54$ on clinical staging). In univariate analysis a number of MRI features were significantly associated with outcome: tumour size, posterior wall infiltration, number of walls involved and presence of hydronephrosis (all $p<0.05$). After adjustment for clinical T stage and tumour grade, these MRI features and the MRI T stage were found to confer additional prognostic information in predicting early disease relapse and death ($p<0.05$). CONCLUSION: This study demonstrates that MRI prior to radiotherapy adds important prognostic information independent of clinical staging.

0850

Digital luminescence mammography in clinical use

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PURPOSE: Consequent upon the results of a phantom study we carried out, mammography was performed using only luminescence storage plates for digital processing. We present our experiences of this digital technique and provide an overview of the equipment necessary for its clinical use. METHODS: In February 1998 we replaced conventional film screen mammography with high resolution phosphor storage plates (Fuji IP HR V, format 24 x 30 cm) in combination with a Mammomat 3 (Siemens) and a DIMA Plus M 11 (Feinfokus), read by a Fuji AC 3 M (matrix 4170 x 4300, >10 pixel mm^{-1}). The images are printed by a Fuji FL-IMD laser printer (line distance 50 pm). Prior to August 1998, we acquired 2500 mammograms using this technique. In addition, we investigated the size extension of microcalcification in 100 patients by a special post-processing program and correlated the results with the histological findings. By using high resolution storage plates and the appropriate processing equipment, a spatial resolution of 8 1p mm^{-1} is possible and the quality criteria given by law are filled. Thus, all the advantages of digital radiography can be used in mammography.

0900

Breast screening interval cancer targets: can they be met?

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OBJECTIVE: To review the results of breast cancer screening in the South Thames (West) Region over 10 years from 1987 to 1997. DESIGN: Regional performance measures taken from Department of Health KC62 returns and data from the Regional Quality Assurance Centre have been correlated with National Health Service Breast Screening Programme (NHSBSP) targets. The main measures studied were uptake, cancer detection rates and interval cancer rates. RESULTS: Uptake rates in the Region are consistently slightly lower than the national average. The standardized detection ratio (SDR) for prevalent (first) screening between 1990 and 1997 for the region was 1 (95% CI 0.94–1.06). During the same period for incident (subsequent) screens the Region had an SDR of 1.06 (95% CI 0.98–1.15). The interval cancer rates for the period 1990–1994 for 0–23 months after a negative screen were 1.23 per 1000 (95% CI 1.06–1.42) compared with the national target of less than 1.2 per 1000. Comparison of the three programmes in the Region showed an inverse relationship between SDRs and interval cancer rates. The highest SDR was reported by the programme which has always used two-view mammography for all screens together with double reading with arbitration. CONCLUSION: The three programmes in the Region have collectively achieved close to or exceeded targets set by the NHSBSP for uptake, cancer detection rate and interval cancer rates. The authors are going on to examine breast cancer mortality in the Region which has substantially declined since the start of screening.

0910

A method of simulation to improve system parameters in digital mammography

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PURPOSE: Monte Carlo methods are used to evaluate the potential for dose reduction in small field mammography. Choice of imaging variables, including geometry, influences subject contrast of objects of interest, degrading effects of scatter and ultimately determines threshold visibility. Computer simulations are used to examine the capability of different imaging parameters, including focal spot size to visualize details of interest in different tissue types. METHODS: Code simulating geometries, focal spot and spectra have been written. Pertinent tissue compositions have been used with objects of interest placed at different distances from an imaging plane. Indicators including signal-to-noise ratio (SNR) and contrast resolution are employed to examine aerial photon distributions that are used to form pseudo digital images where the image quality tends to be quantum limited. RESULTS: Analysis of SNRs has yielded optimum energies to visualize microcalcifications in different depth simulated tissues. These are in agreement with existing literature, between 16 and 22 keV for a 200 μm calcium hydoxyapatite microcalcification embedded at a depth midway between 3 and 6 cm thickness average breast tissue. A subjective interpretation of the images combined with the SNR has revealed that for calcifications of

between 0.2 and 2.0 mm, imaging parameters and geometries which produce SNRs of 2.0–2.5 are required for the calcification to be in the region of "borderline detectability". CONCLUSIONS: Mathematical modelling is a powerful tool in multiparameter optimization. Simulations may be used to prescribe required geometries to see lesions of known subject contrast at particular distances from imaging planes in different tissues.

0920
Gamma camera PET in suspected chest malignancy
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The utility of dual headed gamma camera PET with 18FDG was analysed in 11 patients with lung nodules on CT scan. These lesions were inaccessible to biopsy or had had an inconclusive biopsy. Imaging was with an ADAC MCD gamma camera using 120 MBq of 18-fluoro-deoxy-glucose. The clinical course and subsequent imaging were reviewed. Mean follow-up 7 months (range 2–30 months). Lesion size ranged from 0.8 to 5 cm (Mean 2 cm). Of 12 lesions 8 were PET positive. Two of these less than 1 cm. In 7 of these malignancy was confirmed, 2 by re-biopsy, 1 died of carcinomatosis and 4 had progression of disease. One lesion was falsely positive on PET, although this patient had 2 lesions and the other was truly positive. Of the 4 PET negative lesions 3 had no progression of disease. In the falsely negative case an unsuspected truly positive pharyngeal tumour was revealed. Gamma camera PET accuracy in chest malignancy = 83%.

0930
Discussion

1400–1515
Work in Progress
New Observations
Olympian Suite

1400
The Toronto Hospital CT productivity study
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The full benefit of technological advances within diagnostic imaging cannot be achieved without carefully orchestrated improvements at every step of the image delivery process and without complete acceptance from stakeholders. The Tri-Hospital Department of Medical Imaging chartered the CT Change Acceleration Process (CAP) Team to drive change which would permit patients, referring physicians and the department to benefit from advances in technology provided by the advent of new scanners, PACs and RIS. The CAP Team commenced its effort by sponsoring a current situation assessment of the CT department. The assessment revealed that scan rooms remain empty for approximately 30% of the time. This inefficiency is primarily the result of order processing (booking and protocoling) and patient registration processes. If the CT department is to benefit from productivity gains achievable with the new scanners, the upstream order processing and patient registration processes need to be modified to ensure a steady flow of patients to the scanners. The assessment also revealed that average CT report turnaround time for electronically generated reports is currently in excess of 3 days with 55% of the time attributed to report verification. Root causes of delays in report verification will need to be understood and addressed in order to benefit fully from increased speed of report generation achievable with new technologies such as PACs and RIS. By sponsoring process improvement to address these two key areas of productivity and quality of scan delivery enhancements, the CT Department at the Tri-Hospital Department of Medical Imaging will be able to benefit more fully from advances in technology provided by the new scanners, PACs and RIS. As an in progress study the results of the first experiment to improve these statistics is still awaited.

1410
Radiological investigation of chronic scrotal pain
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PURPOSE: It is often difficult to establish the aetiology in patients with chronic scrotal pain. Most routine investigations tend to be normal and treatments therefore unsuccessful. We present the findings of a prospective study looking at the usefulness of radiological investigations in these patients. PATIENTS AND METHODS: Between October 1997 and January 1999, 41 patients (mean age 39.8 years) with chronic scrotal pain were studied prospectively. In addition to a clinical assessment and routine laboratory investigations, 24 had one or more radiological investigations performed. These mainly included testicular and transrectal ultrasound and videocystometry (VCMG). RESULTS: Testicular ultrasound was performed in 21 patients with abnormal findings in 13, including testicular cysts (4), varicocoeles (4), scrotal calculi (2) and epididymal/testicular inflammation (3). Transrectal ultrasound was performed in 18 patients and revealed abnormal findings in 13 (72.2%) including evidence of chronic inflammatory prostatic disease in seven (38.9%), bladderneck hypertrophy (1), ejaculatory duct calcification without dilatation (2), periurethral ductal calcification (1), and one patient with bilaterally distended obstructed seminal vesicles with vasal reflux. 14 VCMGs were performed of which four (28.6%) were normal. The abnormal findings included intraprostatic reflux in three, bladder neck obstruction in three cases, false positive trapping sign in two, bladder diverticulum in one and a posterior urethral diverticulum in one. CONCLUSIONS: The percentage of abnormal findings of these radiological investigations was significant. Transrectal ultrasound and VCMG are not routinely performed in the evaluation of patients with chronic scrotal pain but they may provide the opportunity for better medical and surgical treatment.

1420
An analysis of the effectiveness of a computer based information system for general medical ultrasound patients
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BACKGROUND: A multimedia information system was created for general medical ultrasound patients. The system runs on a PC under Windows '98. Narrated video, pictures, diagrams and an interactive questionnaire were included in the system. The system was located a patients' waiting room within an inner city teaching hospital. PURPOSE: To evaluate the effectiveness of the system, by comparing knowledge of patients who had and had not used the system. METHOD: Two groups of patients were studied: group 1 (100 patients) had their knowledge assessed prior to scanning, this group did not use the system; group 2 (100 patients) had their knowledge assessed after using the information system, again prior to being scanned. A multiple choice questionnaire was used to assess patient knowledge, questions were based on what patients should know about the ultrasound scanning process. All patients who participated in the study received the routine "traditional" information from the ultrasound department. RESULTS: Group 2 demonstrated a higher knowledge (88%) than group 1 (65%), this difference was significant ($p < 0.01$). Since the groups were not randomized, confounding factors were introduced; these will be analysed during the presentation. CONCLUSION: Patients who used the system had a higher knowledge of the scanning process compared with those who did not use the system. Computerized information systems may therefore play an important role in the education of patients who are to undergo diagnostic examinations.

1430
Mucosal integrity of sigmoid strictures: a reliable sign of benign disease
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Several features of a sigmoid stricture on barium enema examination have been postulated to be helpful in predicting malignancy. Their value was assessed in 46 barium enemas in which the diagnosis had been established either by excision or by greater than 6 months follow-up, and in which the diagnosis was not obvious radiologically. A consultant radiologist with great experience in this field scored the enemas according to stricture length, presence of diverticular disease, abruptness of the proximal and distal ends of the stricture, evidence of perforation, evidence of extraluminal mass, eccentrically of the stricture and the preservation of mucosal folds. In this group of patients the only features which correlated well with malignancy were abruptness of the distal end (accuracy = 76%) and loss of mucosal integrity (accuracy = 91%, sensitivity = 91%, specificity = 92%).

1440
Radiographic positioning of patients for knee examinations using a computerized patient positioning device
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PURPOSE: Reject analysis studies were undertaken prior to this research project and proved that inaccurate patient positioning is by far the major cause of overexposure in diagnostic radiography. After an intense study of lumbar spine examinations using a specifically designed computer system for patient positioning, results of clinical trials, using 400 patients for lumbar spine examinations, suggested a major improvement in the accuracy of positioning patients. The aim of the work in progress is now to eliminate the need for repeat radiographs for knee examinations. METHOD: An intensive anatomical study to estimate patient variability owing to normal and abnormal biological configurations of the knee joint is being undertaken with the aim of formulating an anatomical reference computer database. A CCD camera recording system is used in conjunction with retroreflective markers, which are placed onto the patients using the anatomical landmarks for anteroposterior and lateral projections. By using the study's anatomical database related to patients' size and anatomical structure, patients are positioned automatically using this device. A study population of 50 patients (100 projections) were examined for knee examinations. These results are being compared with the same number of patients positioned conventionally for knee examinations. This device is also used to confirm the focus-to-film distance and monitor patient movement before and during X-ray exposure. INITIAL RESULTS: The percentage of accurately positioned patients using the device was found to be 97%. CONCLUSION: The accuracy achieved by using the computerized device suggests a significant reduction in radiation dose to patients.

WORK in PROGRESS

1450
Transactional analysis and its application to diagnostic radiography
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PURPOSE: To identify the way in which radiographers interact with patients, and design a test tool that can be used to conduct further research in this area. DESIGN AND SETTING: A descriptive study design was completed in the radiology departments of a number of hospitals in the north west of England. METHODS: Initially, verbal and non-verbal interactions between radiographers and patients were observed. The results of these observations were analysed and an observation test tool designed. Subsequent interviews validated the results of the observations with radiographers self-reporting the observations. RESULTS: The observations and interviews revealed that radiographers appear to interact with patients in one of five ways. These five "interaction styles" have been recognized as being similar to the ego states known as: nurturing parent; critical parent; adult; free child; adapted child, which were introduced in Berne's Transactional Analysis in 1961. Conclusion: Barriers to the communication in the radiographer patient include: short interaction times; the highly technical nature of the departments; the nature of patients' conditions. The application of transactional analysis to diagnostic radiography offers a means of observing interactions and identifying problems in existing methods of communication. In addition, transactional analysis can be used as a tool for guiding communication during interactions with patients and their relatives.

1500
Discussion

1545–1700
Work in Progress
Education Topics
Hall 5

1545
A simple example of continuing professional development for all
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PURPOSE: This presentation looks at an example of continuing professional development (CPD) which involves all radiographic staff in the department as part of their day-to-day work. The intention is to heighten radiographers' awareness of pathological conditions and normal anatomical variants evident on radiographs and images produced by more specialized imaging modalities. METHOD: Radiographers and radiologists are asked to look out for interesting images from the current workload. These images are then displayed in a prominent position within the viewing area along with a short written explanation describing the radiological findings and points to note in relation to practice. The images are changedweekly and stored in a film file for future reference. All radiographers are encouraged to take part by providing images and written explanations. RESULTS: Initial findings indicate that having the images on display has stimulated the interest of radiographers, provoking debate and questioning of accepted departmental practices. During out-of-hours work, medical and nursing staff from wards and the Accident and Emergency Department have found the images of interest. CONCLUSION: Although this example of CPD for all was motivated by the interests of a senior radiographer, it has become self-perpetuating. Radiographers gain reward from their input andefforts owing to a sense of ownership. The prestige of the department and the profession is increased as the images are on show to others. It is a simple and accessible example of CPD utilized in one X-ray department but which could be adopted by any department.

1555
A new approach to clinical assessment in undergraduate education
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Effective means of assessing student competency in the clinical environment is an ongoing concern for all those responsible for the training and education of student radiographers. By definition, competency implies the ability consistently and reliably to attain specific standards in a range of contexts and acquire the knowledge to underpin that ability. During 1997–1999, South Bank University had the opportunity to redesign their method of training student radiographers. The advent of national occupational standards in healthcare provided a framework for assessing competence. This framework of performance criteria and range statements has been transposed into pre-registration radiographer education to create a structure for continuous assessment of clinical competency. The system was devised in conjunction with clinical colleagues and is being used within the BSc (Hons) Medical Radiation Studies as of September 1998. It is hoped that this innovative system will reduce subjectivity by the formalization of the steps leading to competency in clinically based tasks. It is felt that this system could be adopted by groups of educators on courses containing similar mixtures of academic knowledge and clinical skills. The presentation will explain both rationale and construction of the elements of competence and report on its administration within the clinical setting.

1605
CDROM image database for medical physics training — EMERALD
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INTRODUCTION: Modern radiology requires well trained medical physicists; however, limited time is available for use of medical equipment for training purposes. A consequence of this situation is the use of contemporary educational techniques to increase the effectiveness of training. The Leonardo da Vinci EU project for European Medical Radiation Learning Development (EMERALD), a Consortium of Universities and Hospitals from UK, Sweden, Italy and Portugal, has developed three training modules in medical radiation physics (diagnostic radiology, nuclear medicine, radiotherapy). Each Training Module consists of Workbook with tasks, leading to certain competencies (based on the IPEM Training scheme) and a CDROM with image database (IDB). RESULTS: The volume of the IDB comprises about 1200 images of radiological equipment and its components; block diagrams and performance parameters, graphs, waveforms; QA procedures and measuring equipment; test objects and image quality examples; typical images and artefacts etc. A PC-type image browser (ThumbsPlus) is used for quick and easy search through the IDB. The browser presents each image as an approximately 128 × 128 slide, which can be further viewed in its original size (JPEG up to 1024 × 1024 pixels). Each image is visualized with corresponding caption, on which basis a keyword search of IDB can also be

performed. The IDB is engraved on three CDROMs—one for each Training Module. The image organization within each IDB follows the chapters in the Training Workbooks. The EMERALD Training with CDROM Image Database has been tested and its introduction in medical physics practice will commence during the 1999 academic year.

1615
A multidisciplinary approach to clinical education
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PURPOSE: The development and delivery of a masters level postgraduate module in clinical education for health professionals has unravelled some of the complexities which arise and are experienced during the supervision and assessment of students. For the last 3 years, Glasgow Caledonian University has been delivering a multidisciplinary masters level course for clinical educators with two main aims. (1) To challenge clinical educators' perceptions of how best to facilitate student learning, thereby increasing their knowledge base. (2) To stimulate cross-disciplinary discussion of the similarities and differences in clinical education practice. METHODS: On completion of the course, the clinical educators are asked to evaluate their experience of it. In order to ensure concurrent validity two questionnaires are completed: the generic university module evaluation questionnaire and a specially designed, open-response feedback sheet. Reliability was ensured by gathering data from three cohorts who had received identical input as far as possible. Hence both quantitative and qualitative data were gathered. RESULTS TO DATE: Data will be presented on the students' perception of the course and its value in their role as clinical educators. CONCLUSION: Clinical educators did appreciate the need to understand the theories of learning. On return to clinical teaching they experienced a difference in their attitude and organizational abilities and strategies when teaching students. Clinical education atmasters level to mixed cohorts of PAMs and nurses is ongoing and data continue to be collected as the course is refined in light of the perceived clinical needs.

1625
Integration of problem based learning as a major component of an undergraduate radiography curriculum
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Conceptually and practically, applying the principles of problem based learning (PBL) to radiography education, where the format follows the conventional block pattern, may be problematic, particularly where logistics of clinical practice placement may impact on the overall coherence of a programme. Although now less apparent in the UK, the tendency to "spoon feed" or over-structure the learning of students must be resisted in order to achieve the desired outcomes of reflective practice and active enquiry. Problem based learning is identified as a significant tool in meeting this aim. In the 1997–1998 review and revalidation of the undergraduate radiography curriculum, the Division of Professions Allied to Medicine took the opportunity to integrate PBL as a major part of the teaching and learning strategy. The resulting design which is essentially unitary in format, was based on a range of consultations with colleague institutions, although the structure and delivery is specific to the parameters of the programme. Indeed, the system in place, although true to the concept of PBL, is a unique process and among few in UK radiography education to be applied extensively. This work in progress evaluates the first year of delivery of PBL in this situation and should be of interest to those involved in the delivery or management of health education. Problems, solutions and successes are reviewed from the perspective of resource and logistical issues. Also considered is the cultural change associated with what is a significant shift of emphasis for both staff and students.

1635
The lecturer practitioner — a new breed for diagnostic imaging
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PURPOSE: The role of the lecturer practitioner is well established in the nursing world, but it is a relatively new concept in diagnostic imaging. This post, which came from an initiative between Guy's and St Thomas' NHS Trust and South Bank University, began in July 1998. Created with the primary aim of maximizing the educational experience of student radiographers in both the clinical and academic environment, it forms a bridge between theory and practice. Ongoing evaluation and success of the initiative is a crucial aspect of quality monitoring strategies. This study will be of interest to radiographers and lecturers involved in the development and delivery of undergraduate programmes. MATERIAL/METHODS: Data collection utilizes a mix of qualitative and quantitative approaches incorporating the use of interview and questionnaire applied to both students and staff. This includes lecturers who teach on the undergraduate programme and a stratified sample of radiographers from the hospital trust. Feedback on clinical tuition and support, academic input communication issues and pastoral care is assembled including, specifically, the perspective of the student experience. RESULTS: Initial findings indicate a high level of acceptance of the role. In particular, the beneficial impact on the academic/clinical relationship is noted, as is the apparent enhancement of the student experience. In the long term, it is expected that analysis of results will demonstrate an overall benefit to the educational outcome for students.

1645
Discussion

1545–1700
Work in Progress
CT Topics
Olympian Suite

1545
Comparative evaluation of urinary tract tuberculosis by intravenous urography, sonography and multiphasic CT
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PURPOSE: To describe the imaging features of urinary tract tuberculosis (UTTB) on ultrasound (US) and CT and compare them with intravenous urography (IVU). MATERIALS AND METHODS: IVU, US and multiphasic CT of 32 patients (20 males, 12 females; mean age 24.8 years) with proven UTTB were retrospectively analysed. All cases were proven either by isolation of acid fast bacilli by culture (13), direct smear (11), biopsy (5), or by response to therapy (3). Grey scale US of the urinary tract was performed using a 3.5 MHz curvilinear transducer. Four-phase abdominal CT was performed on a helical scanner. Tailored studies were performed using IVU. RESULTS: IVU, US and CT were abnormal in 29, 27 and 28 patients, respectively. All studies were normal in three patients. Common CT findings included focal hypodense lesions (7), patchy renal enhancement (7), calcification (6) and focal caliectasis (4). CT was the best modality for detection of extrarenal lesions. US findings included focal renal lesions (8), calcification (5) and caliectasis (4). Hydronephrosis (10), parenchymal scarring (6) and thick walled, small capacity bladders were equally well visualized by both US and CT. Ureteric abnormalities were better seen by CT (13) than by US (7). IVU was normal in two patients with focal renal lesions seen on US and provided inadequate information on nine patients with poor renal function. Biopsy of focal renal lesions seen on US and CT proved to be tubercular granulomas. CONCLUSIONS: Excepting IVU, all patients with suspected UTTB must undergo either US or multiphasic CT study. Focal renal lesions seen on US may be characteristic of renal TB in cases with a high clinical index of suspicion. Patchy renal enhancement and focal hypodense lesions are not an uncommon finding on CT in UTTB.

1555
Intravenous CT portography: a new method of evaluating extrahepatic portal hypertension and surgical portosystemic shunts
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PURPOSE: To evaluate the splenoportal axis and patency of portal systemic shunts in extrahepatic portal hypertension (EHO) by intravenous CT portography (CTP). METHOD/MATERIALS: 68 patients with EHO (49 pre- and 19 post-shunt, average age 28.4 years, male/female ratio 7:2) were evaluated. The 19 surgical portal systemic shunts comprised 14 proximal and two distal lienorenal, and three mesocaval. All patients were subjected to CTP on a Somatom Plus 4 (Siemens, Erlangen, Germany) spiral CT scanner. Thin, axial, overlapping sections were obtained. Arterial vasculature

and bony structures were edited by segmentation techniques, followed by 3D rendering. The findings were correlated with colour Doppler flow imaging. RESULTS: In 47 of 49 cases of EHO, the exact site of block demonstrated on CTP correlated with CDFI (two cases were not well evaluated on CDFI). Out of the 19 shunts, five were patent and 14 were blocked. The results were in agreement with CDFI in 17/19 cases. Two shunts could not be evaluated on CDFI. Global 3D view of all the collaterals and the splenoportal axis found excellent acceptance by our surgeons. Specific CT findings suggesting the primary aetiology (hepatocellular carcinoma, chronic calcific pancreatitis, cholangiocarcinoma, sclerosing cholangitis etc.) could also be demonstrated. CONCLUSIONS: CTP is a promising new technique to evaluate pre- and post-shunt cases of EHO. This modality has the potential to replace the more invasive angiographic techniques and may be useful in situations where CDFI is inconclusive or limited by poor visualization.

1605

Marked hemithorax volume loss seen at CT: incidence and aetiology in Wegener's granulomatosis

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PURPOSE: CT is increasingly being used to monitor disease progress in thoracic Wegener's granulomatosis (WG) in order to assess the benefits of the effective but toxic drugs available. The CT features are well documented. Local lung volume loss has previously been noted, but marked asymmetrical hemithorax volume loss has not been described. There are several mechanisms by which WG may lead to lung volume loss, including a fibrothorax secondary to pleural disease, obstructive atelectasis secondary to endobronchial lesions, and cicatrising atelectasis resulting from the healing of vasculitic nodules. We aimed to determine the incidence of asymmetric hemithorax volume loss in patients undergoing CT for WG and to review these CT scans for evidence of aetiological factors. METHOD: All CT scans of the chest performed on patients with a diagnosis of WG between 1993 and 1998 were reviewed. There was a total of 15 examinations, investigating eight individual patients (4 female, 4 male, age range 25–66 years). Three CT scans on three different individuals demonstrated asymmetric volume loss of a hemithorax. For these patients, the CTs were assessed for evidence of airways (bronchiectasis, endobronchial lesions, lobar collapse and compressing lymph nodes), parenchymal (nodules, consolidation, parenchymal bands, reticular and "honeycomb" change) and pleural disease. Previous imaging and the clinical notes were reviewed for evidence of aetiogical factors. RESULTS: The results will be presented. CONCLUSION: Marked volume loss of a hemithorax should be added to the previously recognized CT features of thoracic WG.

1615

Correlation between linear ultrasound measurements of splenic size and 3D CT volumetric analysis

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PURPOSE: Ultrasound measurement of splenic size is standard practice, but it is not known how well this represents true splenic volume. Previous studies using a combination of measurements from *in vivo* and resected spleens are prone to error owing to changes in splenic size. Our aim was to correlate the dimensions of the spleen measured by ultrasound with the splenic volume measured by spiral CT. METHODS: Ultrasound was performed on patients undergoing abdominal CT examination. The length, width and depth of the spleen were measured with the patient in the supine and right lateral decubitus positions. Splenic volume was calculated from a three-dimensional (3D) reconstruction of CT images acquired on a single breath-hold. The accuracy of the CT assessment was established by the use of phantoms. The linear dimensions of the spleen were correlated with the CT volume (Spearman's rank correlation), as was the splenic index (defined as the product of the length and width of the spleen) and the estimated splenic volume (defined as the product of the length, width and depth of the spleen). RESULTS: 35 patients have been studied to date. The linear measurement that correlated best with the CT volume was the depth of the spleen measured in the supine position ($r=0.84$, $p<0.001$). The splenic index also correlated well with the CT volume ($r=0.83$, $p<0.001$), as did the estimated volume ($r=0.83$, $p<0.001$). CONCLUSION: A good correlation exists between the *in vivo* ultrasound measurement of splenic size and the true splenic volume. The most reliable single measurement is the depth of the spleen.

1625

The value of prone imaging in CT pneumocolon

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PURPOSE: To evaluate the role of prone imaging in CT pneumocolon. MATERIALS AND METHODS: In the UK, this technique usually involves the acquisition of axial images in the supine position alone. A retrospective analysis of supine only images and a prospective analysis of both supine and prone images were performed. Patients were scanned according to standard pneumocolon protocol: standard bowel preparation, air insufflation following administration of buscopan/glucagon, dynamic arterial phase intravenous (iv) contrast and dual spiral CT scanning using 5 mm collimation, pitch 1.5, reconstruction interval 2.5 mm. The colon was divided into five segments for assessment. The degree of distension and the presence/absence of fluid/faecal residue were documented. The supine scanogram was also assessed to determine whether it is possible to predict adequate distension of all segments of colon, thus negating the need for prone imaging. RESULTS: 22 patients were scanned in the supine position alone. The degree of distension was diagnostic in 94% caecum/ascending colon, 100% transverse colon, 73% descending colon and 76% rectum; but only 40% within the sigmoid colon/rectosigmoid junction. To date, 12 patents have undergone supine and prone scanning. In each case, all five segments of the colon have been well visualized on combined assessment of supine/prone images. Problems encountered owing to fluid/faecal residue were eliminated on prone scanning. Initial assessment of the supine scanogram has suggested that small areas of collapse and collapse of the distal sigmoid colon/rectosigmoid junction are not predictable. CONCLUSION: Prone imaging is a useful adjunct in the CT assessment of colonic pathology and reduces problems caused by poor distension, fluid and faecal residue.

1635

Towards a computer simulation of CT images of the head

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Computer simulation of radiological images offers the possibility of producing clinically realistic image datasets with precisely defined contents. These would be valuable tools in a wide range of imaging technology assessment applications, including evaluation of image registration and image fusion techniques, image perception studies, evaluation of image processing algorithms and receiver operating characteristic (ROC) analysis. The proposed method of producing simulated clinical CT images starts from a high resolution three-dimensional (3D) template representing the variation in the appropriate tissue properties over the region to be imaged. This template image is then degraded using a model of the image acquisition process. The template image has been derived from the anatomical dataset produced by the US National Library of Health Visual Human Project (VHP), by segmentation followed by assignment of an appropriate CT number or linear attenuation coefficient to each compartment. To a first approximation the image acquisition process can be modelled as a convolution with the point spread function of the CT scanner followed by the addition of noise. This presentation will include a discussion of the measurements of scanner performance required to enable realistic image simulation and a comparison of real and simulated test object images, and will show examples of simulated CT images of the brain.

1645

Discussion

WORK in PROGRESS

1615–1645
Work in Progress
IMRT/IT for Radiotherapy
Hall 6

1615

Intensity modulated radiotherapy (IMRT) in tumours of the head and neck

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PURPOSE: Using intensity modulated radiotherapy (IMRT) it is possible to deliver a radical radiation dose to a concave target

volume while sparing radiosensitive normal tissues within the concavity. We have applied this technology to tumours in the head and neck region to estimate the potential benefits of IMRT over conventional radiotherapy. PATIENTS AND METHODS: Conventional radiotherapy plans were compared with IMRT plans from the CORVUS inverse planning system (NOMOS Corporation) for four patients treated for carcinoma of the thyroid and parotid gland. RESULTS: For patients with thyroid cancer the goal was to deliver 60 Gy to the thyroid bed and upper deep cervical lymph nodes (a concave target volume). The conventional treatment in two phases achieved a minimum target dose of 48 Gy limited by a maximum spinal cord dose of 44 Gy. IMRT could have achieved the goal target dose with a spinal cord dose of less than 30 Gy. For patients with malignant parotid tumours 60 Gy was delivered to the parotid bed. For conventional treatment the mean doses to the cochlear, contralateral parotid gland, oral cavity and spinal cord were 48 Gy, 2 Gy, 20 Gy, 20 Gy, respectively. Using IMRT they were 27 Gy, 2 Gy, 16 Gy and 20 Gy. CONCLUSION: The dose that can be delivered to the thyroid bed and adjacent nodes with conventional radiotherapy is limited by its proximity to the spinal cord. IMRT improved the dose distribution and could allow dose escalation. For parotid gland tumours, IMRT conformally avoids radiosensitive normal tissues which may reduce complication rates.

1625

Development of an intelligent oncology workstation for the 21st century

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PURPOSE: To develop an intelligent oncology workstation to automate the diagnostics and planning of cancer treatment via intensity modulated radiation therapy (IMRT) from the organ/tumour outlining stage to optimization of radiotherapy treatment plans. MATERIALS AND METHODS: The intelligent oncology workstation builds on previously developed experimental IMRT optimization software and medical image segmentation software (MISS). The IMRT software, implemented using the MATLAB programming environment, with use being made of adaptive least squares and multiple objective genetic algorithms to determine the optimal number, orientation and intensity modulation of X-ray photon beams. MISS uses hybrid image segmentation techniques, based on region growing, to outline all the regions of interest within CT images simultaneously. MISS was implemented on a UNIX based workstation using "C" programming languages with a MOTIF-based graphical user interface. The two developed algorithms are to be integrated and will form the basis of the oncology workstation platform, upon which additional modules can be built. RESULTS: The multiobjective optimization approach has been demonstrated practically and has shown a clear sparing of healthy tissues. Body structures in the pelvic region outlined with MISS were similar to those manually outlined by five clinicians, except in the case where the manual outlining was based more on clinical knowledge than on information contained in the CT images. CONCLUSIONS: The IMRT optimization software is currently being implemented within a commercial radiotherapy treatment planning software package. MISS is being extended to exploit the knowledge from clinicians as well as information from the medical images to segment regions of interest. The next stage is to assess the benefits of the algorithms as practical radiotherapy treatment planning tools.

1635

On compensator design for intensity modulated radiation therapy (IMRT)

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PURPOSE: The aim of the overall project is to assess the effectiveness of realizing IMRT, by means of compensators, in a clinical environment. This paper reports on a new method to work back from a beam intensity profile to a beam modifier (*e.g.* compensators) which produces the desired dose profile. MATERIALS AND METHODS: Time series analysis, appropriately extended to the spatial domain, is applied to predict compensator shapes from beam intensity profiles. The process of intensity modulation by means of compensators can be visualized as a system with the dose distribution to be produced as the input and the compensator shape to be predicted as the output. A mathematical model to describe this system can be determined by observing the input/output data where characteristic parameters are identified by means of linear least squares. RESULTS: The predicted compensator profiles show good agreement with measurements taken. Owing to the penumbra of the beams, the predicted compensator profiles are overestimated (thicker) at the edges of the field. Experiments have shown that, when comparing a measured compensator profile with one that is predicted, the predicted profiles are slightly smoothed. CONCLUSIONS: The smoothing of the compensator profiles is due to scattering. Further work is required to show whether the predicted (or smoothed) profiles will produce the same intensity profiles as those which are produced by compensators machined with standard milling tools.

Posters

National Indoor Arena Concourse Area

Work in Progress

Audit

POSTER 0109

Audit of adequacy of image guided biopsies in an oncology centre

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AIM: To assess the adequacy of ultrasound (US) and CT guided percutaneous biopsies. METHOD: All US and CT guided biopsies performed between January 1997 and December 1998 were assessed. For each biopsy the site, operator, imaging technique and biopsy technique (fine needle aspiration (FNA) or core-cut) were recorded. The pathology report (cytology and/or histopathology) was obtained and the result classified as one of three outcomes: adequate and diagnostic, adequate but non-diagnostic and inadequate. Adequacy was defined as a tissue sample representative of the lesion. The standard for adequacy of the biopsy specimen was set at 80%. RESULTS: 224 biopsies (101 CT guided and 123 US guided) were performed during the 2 year period. In 22 cases no results could be identified, leaving 202 procedures for audit. 167 (83%) procedures resulted in adequate specimens (85% CT guided and 81% US guided). Of these adequate specimens 147 (87%) were diagnostic and 22 (13%) non-diagnostic. Adequacy of both FNA and core-cut specimens exceeded the standard (80% and 91%, respectively). During the 2 year period prior to this audit 55 CT guided and 13 US guided biopsies were performed. This represents an increase of over 300% for an oncology centre where the diagnosis is usually made prior to referral. CONCLUSION: This audit confirms that clinicians are requesting an increasing number of image guided biopsy procedures. The standard set for biopsy adequacy was reached. It is important that as the number of procedures performed increases our practice is regularly audited to ensure those standards are maintained.

WORK in PROGRESS

Breast

POSTER 0503

Is mammography useful for the evaluation of tumour response to pre-operative chemotherapy?

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PURPOSE: To determine the advantages and limitations of a mammographic examination in evaluating the effectiveness of pre-operative chemotherapy. MATERIALS AND METHODS: From January 1996 to December 1998, 24 patients (aged 33–69 years) with breast cancer who had received pre-operative chemotherapy were included in this study. Mammography was performed prior to pre-operative chemotherapy (five drugs regimen: VCR, MT, 5FU, CTX, prednisone) and 6 weeks after. All mammograms were taken using the same appliance, a LORAD M III, in craniocaudal (CC) and MLO projection. The clinical and radiological diagnosis of breast cancer was confirmed by fine needle aspiration biopsy or core needle biopsy. Patients were operated upon even if no signs of tumour reduction were observed on mammography. Histological examination of the specimens was performed. RESULTS: The mammographic appearances of breast cancer were: (1) stellate or spiculated lesions, (2) calcifications, (3) calcifications in combination with (1). In 21 (87%) cases of mammographic examination performed after pre-operative chemotherapy, changes in the mammographic appearance of breast cancer were noticed. In only three cases were no changes in the mammographic appearance of breast cancer observed. Histological examination of 15 (62%) women confirmed the mammographic evaluation by pre-operative chemotherapy. In 14 cases we found a positive effect of having used pre-operative chemotherapy on both mammographic and histological examinations. CONCLUSION: Our results show that mammography would be useful for the evaluation of tumour response to pre-operative chemotherapy; however, the diagnostic criteria have not yet been fully established.

Education

POSTER 0207

Radiographers' perceptions of patients based on dress codes

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PURPOSE: To test the hypothesis "radiographers' perceptions of patients are affected by what a patient is wearing". DESIGN AND SETTING: A survey method which made use of questionnaires and attitude scales was completed in the radiology department of a district general hospital. Method: Using stimulus photographs, a patient was dressed in five different styles of clothing: (1) as a professional, dressed in a suit; (2) as a doctor, dressed in a white coat; (3) as a student, dressed in black jeans and jumper; (4) as a patient, dressed in an X-ray gown; (5) socially, dressed in a short black dress. Each week, 16 radiographers were shown a different photograph and asked to indicate on an attitude scale their thoughts on the chance of each patient demonstrating the following behaviour: violence; misunderstanding the instructions given by the radiographer; antisocial behaviour; having a knowledge of medical radiation; requiring a repeat radiograph owing to some fault by the patient; understanding the reasoning behind the radiograph. RESULTS: Using the statistical test ANOVA, significant differences were found in the radiographers' perceptions of each patient. The patient dressed socially was rated as being most likely to behave antisocially (3.04, $F=2.45$) and violently (4.13, $F=2.45$). The doctor was rated as being most likely to have a knowledge of medical radiation (4.89, $F=2.45$). Both the doctor and the professional were rated as having an understanding of the reasoning behind the radiograph (2.77, $F=2.45$), whereas the photograph that depicted the patient was rated as being most likely to both misunderstand the instructions (2.77, $F=2.45$) and require a repeat radiograph (2.76, $F=2.45$). CONCLUSION: This study demonstrates that radiographers use non-verbal communication cues, provided by clothing, to form an assessment of a patient's likely behaviour. The main implications of these findings is that radiographers may exhibit positive or negative interpersonal attitudes towards patients depending on the dress codes of their clients.

Gastrointestinal

POSTER 0910

CT evaluation of abdominal tuberculosis: a pictorial review

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Abdominal tuberculosis (TB) is primarily endemic in the developing world and has shown a recent resurgence in the west. CT provides valuable information about the involvement of the bowel, peritoneum, lymph nodes and solid organs in a single examination. The role of radiology in abdominal TB includes diagnosis, defining extent, recognizing and assessing complications and follow-up. However, no single radiological feature is diagnostic of the disease in isolation. Findings are at best "highly suggestive" and have to be correlated with clinical and laboratory parameters. We present a spectrum of CT findings in abdominal TB selected from a large retrospective study of proven cases. The findings encompass common and rare features of TB and its complications in the abdomen. In the gastrointestinal tract, features ranging from subtle extramucosal disease to advanced changes are shown. Apart from common complications such as strictures, intestinal obstruction and perforation, less common features such as duodenal obstruction by

lymph nodes, enterocutaneous fistulae with parietal abscesses, enterovesical fistula and intussusception, are demonstrated. Rarer sites of primary involvement, such as TB of the stomach and the gall bladder, are also included. Genitourinary TB and TB in AIDS are not included as they merit separate discussions.

POSTER 0911
Endorectal MRI: pitfalls in the staging of rectal tumours — a pictorial essay with pathological correlation
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The pre-operative stage of rectal tumours is a vital determinant of prognosis and treatment. Although accuracies greater than 80% have been reported for the staging of rectal tumours using endorectal MRI, important pitfalls exist which may lead to staging errors. Technical factors such as compression of the submucosa and muscularis propria owing to the endorectal coil can simulate invasion, resulting in the overstaging of lesions. Stranding in the perirectal fat and/or irregularity of the muscularis propria may be wrongly interpreted as invasion into perirectal fat. Information from both T_1 weighted and T_2 weighted images is frequently complementary since normal bowel wall layers may appear indistinct on one sequence. The purpose of this presentation is to demonstrate these and other pitfalls of endorectal MRI, which may lead to errors in the local staging of rectal tumours. For comparison, examples of correctly staged lesions will be shown. Pathological correlation will be presented wherever possible since this enables a greater understanding of the imaging features.

POSTER 0912
Improved MRI visualization of blood vessels in children with abdominal neoplasms
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PURPOSE: 25 MRI scans, performed at 0.5 T in 24 children with upper abdominal neoplasms, were reviewed to assess whether the addition of a gradient echo sequence to the standard spin echo (SE) sequences improved the visualization of blood vessels. MATERIALS AND METHODS: 12 boys and 12 girls with a median age of 3 years and 5 months (range 1 month to 10 years and 5 months) who between them had 11 nephroblastomas, nine neuroblastomas and four other tumours were studied retrospectively. Axial and coronal T_1 and axial T_2 weighted sequences and a T_1 weighted, magnetization-prepared, turbo field echo (TFE) sequence were performed. The level of confidence, on a five point scale, for the visualization of each of 14 blood vessels, ranging in size from the azygos vein to the aorta, was recorded without and with the TFE images. RESULTS: A total of 323 vessels could be evaluated. The level of confidence was changed for 96 (29.7%) vessels, involving the renal vessels in 46 (14.2%). Vessel displacement or encasement was seen in all cases. CONCLUSION: The addition of the TFE sequence helps the confident identification of abdominal blood vessels. Changes to the application of the TFE sequence to match the axial SE sequences have been made. The results of these changes will also be presented.

POSTER 0913
Quantitative evaluation of anti-CEA antibody labelled with ^{99m}Tc in primary rectal carcinoma
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PURPOSE: A limited number of patients with primary colorectal cancer have been assessed using the anti-CEA antibody. The aim was to detect and assess the CEA scan uptake quantitatively in primary colorectal cancer for possible pre-operative therapy. METHODS: Nine patients with primary rectal or rectosigmoid carcinoma were injected intravenously with CEA scan labelled with 925 MBq of ^{99m}Tc. SPET images were obtained 3 h later, using a dual head gamma camera with an HRGP collimator. The resected specimen was also scanned post-operatively on the same day. The reconstructed transaxial slices were viewed by two independent nuclear medicine consultants to identify the site of tumour. The Chang attenuation correction was applied and activity of regions of interest over the tumour was calculated. RESULTS: The tumour was identifiable on the planar image of the resected specimen. The measured activity was in the range 1.9–7.2 MBq. Mean tumour to background ratio was 2.4 ± 0.6. The overall proportion of tumour identified from SPET images was 89%. One tumour could not be identified as it was scanned 15 h post-injection. Measured activity from the SPET images was in the range 2.3–9.1. CONCLUSION: The accuracy of detection of primary colorectal cancer in this study agreed favourably with previous investigators. There was good correlation between SPET and the specimen activities (cc = 0.89). In light of low tumour to BG activity ratio, an edge detection technique or registration of SPET images with CT or MRI could facilitate the tumour quantitation. Quantitative information can be an important factor influencing patient management, such as pre-operative short course therapy to reduce recurrence.

Musculoskeletal

POSTER 1114
Pre-operative CT localization of spinal level in lumbar disc surgery
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PURPOSE: Medico-legal action relating to surgery in the lumbar spine is increasingly common. Any practice which can reduce errors of identification of lumbar disc level and produce an accurate means of guiding the surgical approach is to be welcomed. METHOD: Currently used means of identification of spinal level were surveyed by questionnaire of 162 consultant neurosurgeons. A CT method was developed to identify accurately the correct spinal level pre-operatively, by injection of methylene blue in to the ligamentum flavum and needle track. An initial radiation dose comparison was made between pre-operative CT and pre- or peroperative radiography. RESULTS: The questionnaire response was 93%. CT guided methylene blue injection was accurate in 46/47 cases of lumbar disc surgery. One case required interoperative radiography owing to a delay of 72 h before surgery. Initial studies of radiation dosage indicate no significant difference in exposure. CONCLUSIONS AND FURTHER WORK IN PROGRESS: CT guided methylene blue injection is accurate and aids minimal surgical approach techniques in lumbar disc surgery. Further work is being carried out to assess a similar CT technique in the thoracic spine and more detailed radiation dose information is being gathered.

Physics

POSTER 1511
Quality assessment of Roentgen Stereo Photogrammetry: a method of retrospective cage calibration
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Roentgen Stereo Photogrammetry (RSA) is a specialized X-ray technique giving precise 3D positions of tantalum beads implanted within bone and prosthetic joint components. One application in orthopaedics is the prediction of early joint failure by accurate migration measurement of total joint prostheses. We have recently installed UMRSA (BioMedical Innovations AB, Sweden), a commercially available RSA method based on Goran Selvik's original published method (Selvik G, Roentgen stereophotogrammetry: a method for the study of the kinematics of the skeletal system, Acta Orthop Scand, 1989, Suppl 232:1–51). An essential part of this method is the integrity of the calibration cage, which must remain distortion-free for precise measurements. Normally results with distorted cages should be rejected. We describe a practical quality control method of assessing extent of cage distortion, and further investigate the feasibility of retrospective correction of film measurements from a distorted cage and report the improvement of measurement precision attained compared with uncorrected measures.

Radiation Safety and Protection

POSTER 1410
Ultrasound-induced morphological change within murine small intestine
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PURPOSE: Ultrasound has been a vital tool for diagnosing disease over the last 40 years. Technological advances have led to the

increased use of modalities, such as Doppler ultrasound, which employ higher intensities. Although these advances improve the diagnostic efficacy of ultrasound, it is important that careful attention is given to investigating potential bioeffects. Recent work has concentrated on the haemorrhaging effects of ultrasound on lung and small intestine, with little attention paid to cell cycle perturbations and apoptosis — two very sensitive indicators of environmental insult. This study addresses this issue by exploring the effects of ultrasound on these two features. MATERIALS AND METHODS: The anterior abdominal surface of male, adult CD1 mice was shaved and exposed to ultrasound. An 8 MHz linear array transducer was manually swept from the midline to the left mouse flank on a continuous basis. Each mouse was scanned for 15 min with B mode and colour flow mapping modes selected. The thermal index for soft tissue (TIS) registered 1.0. The small intestine was excised and histologically examined at various timepoints after treatment. RESULTS: Analysis of the data demonstrates a statistically significant 22% reduction in numbers of mitotic figures at 4.5 h after the ultrasonic insult ($p<0.05$). Numbers of apoptotic bodies also appear to be affected but work is ongoing to quantify this effect. CONCLUSIONS: These preliminary results have established that the bioeffects of ultrasound are more diverse than previously described. Further work will establish thresholds for these deterministic effects.

Radiotherapy & Oncology

WORK in PROGRESS

POSTER 1312

Adverse effect following external radiotherapy of age related macular degeneration: results of a prospective study

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PURPOSE: The prospective evaluation of efficacy and complication rates of radiotherapy in age related macular degeneration. MATERIALS AND METHODS: Between September 1995 and December 1997, 80 patients underwent megavoltage radiotherapy using a lateral D-shaped field (mean follow-up 22 months; range 12–37 months). Complete ophthalmic examination including fluorescein and indocyanin green angiography was performed before and after treatment and then at 6 month intervals. 40 patients received 14.4 Gy/1.8 Gy (group A), in further 40 patients we increased the dose to 25.2 Gy/1.8 Gy (group B). RESULTS: After 6 months the visual acuity remained stable in 19 patients (47.5%) in group A and in 22 patients (55%) in group B. However, after 12 months the vision deteriorated in 34 patients (85%) in group A and in 26 patients (65%) in group B. Stabilization of the neovascular complex was not observed in either group A or group B. Although no severe side-effects occurred during radiotherapy, we found an extensive growth of the CNV in nine patients (22.5%) in group A 18 months after treatment, causing greater functional damage than spontaneous scarring. No similar adverse effect of radiation was observed in the group with the higher dose (mean follow-up 17 months). CONCLUSION: Our results are in support of a follow-up time no less than 12 months being necessary to define the value of radiation therapy of age related macular degeneration. Besides the poor beneficial effect, even in the group with the higher dose, we should be aware of the possibility of excessive growths of the subfoveal lesion after treatment.

POSTER 1313

Combined modulator treatment in low doses reverses adriamycin drug resistance in MCF7-adr1 cancer cell line

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Multidrug resistance (MDR) is a major cause of anticancer treatment failure in a variety of cancers. Most commonly, it is due to overexpression of a transmembrane protein (P-glycoprotein; Pgp). Pgp renders cytotoxic chemotherapy ineffective by removing MDR drugs out of the cancer cells, while *in vitro* MDR reversal has been successful, its clinical application has not been convincing so far, mainly because of unacceptable toxicities at higher doses needed to reverse drug resistance. PURPOSE AND MATERIALS AND METHODS: We tried the modulators PSC 833 and toremifene in a low dose combination to see the reversal of adriamycin resistance in MCF7-adr1 human breast cancer cell line using MTT functional assay technique. MCF7-adr1 was derived from MCF7-adr by continuous exposure to increasing concentrations of adriamycin, and is 3–4 fold more resistant to the parental cell line. RESULTS: Combined use of PSC 833 (0.1 μM) and toremifene (2 μM) resulted in 5.05-fold decrease in the EC50 (from 31.8 to 6.3 μM) of adriamycin compared with 1.03- and 2.02-fold when used alone, respectively. CONCLUSION: This study suggests that low dose combination of modulators may be considered a novel approach to circumvent drug resistance and to avoid unacceptable side effects.

Vascular & Interventional Radiology

POSTER 1213

Colour Doppler: a new method for the guidance of direct percutaneous coil embolization of pseudoaneurysms

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Percutaneous embolization by direct puncture has been successfully employed to occlude pseudoaneurysms, true aneurysms and vascular malformations utilizing fluoroscopy and intermittent contrast injection for guidance. We describe three cases of direct percutaneous puncture and embolization of superficially located pseudoaneurysms under colour Doppler guidance. Two of the pseudoaneurysms developed following trauma and one resulted from a voluntary blood donation in the antecubital fossa. In all these patients angiographic procedures were not feasible with the available set-up, and the patients had refused surgery. The embolizations were performed using "home-made" tailored steel coils which were introduced using a simple "medicut needle" and a guidewire. Colour Doppler can be a useful modality in the diagnosis of such lesions and provides possibilities for image guided compression and the introduction of embolizing materials by direct puncture, or both. The indications, technical considerations and possible complications are discussed. To the best of our knowledge, this is the first account of exclusively having used this modality to guide and control a percutaneous direct puncture and embolization procedure.

POSTER 1214

Magnetic resonance in imaging of central venous system

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PURPOSE: The increasing requirement for central venous access in patients with chronic disease has created a need for a robust technique for imaging central veins. This report describes the use of breath-hold magnetic resonance venography (MRV) of the central chest veins. MATERIALS AND METHODS: Between January 1997 and December 1998, 18 patients with clinically suspected central venous obstruction underwent MRV. All patients were imaged with a 1.0 tesla Siemens Magnetom Impact MR scanner. The imaging sequence was a three-dimensional (3D) steady state gradient echo sequence (FISP) with TE 2.8, TR 6.7 ms, flip angle 30° performed after gadolinium DTPA. This sequence enables imaging within a single breath-hold. Two sets of image data were acquired at 30 and 70 s post-injection to guarantee good venous opacification. Individual partitions and maximum intensity projections of each imaging sequence were analysed. RESULTS: Of the 18 patients imaged, 16 had good quality images with excellent delineation of the central venous anatomy. In two cases image quality was poor owing to inability of the patients to breath-hold. DISCUSSION: In patients with difficult central venous access, imaging of central chest and jugular veins is valuable in ascertaining the optimal site for catheterization. Ultrasound and contrast venography have serious limitations, the former because proximal vessels are obscured by the thoracic cage and the latter because jugular vessels are not demonstrated. Breath-hold contrast enhanced MRI of the central chest veins addresses these limitations and provides excellent images in most patients. We feel this is a very promising imaging technique.

Tuesday 18 May

1400–1630
College of Radiographers
Student Radiographer Conference
Olympian Suite

1400
Chairman's welcome and introduction
J Fisher
The College of Radiographers, 2 Carriage Row, 183 Eversholt Street, London NW1 1BU, UK

1405
Improving C7/T1 visualization in blunt cervical spine trauma on the lateral radiograph, using an aluminium filter
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PURPOSE: ATLS protocol stresses the importance of the cross-table lateral film in blunt cervical trauma. The C7/T1 junction is notoriously difficult to visualize at the first attempt, and approximately 20% of injuries occur here. A "Swimmer's" projection is normally used as an additional projection, but a single lateral showing alignment from C1 to T1 would minimize dose. Filters are used in scoliosis radiography and may be useful in this situation. METHODS: An aluminium filter was constructed, and tested with a phantom. A prospective trial was undertaken on 120 patients requiring cervical spine X-rays following blunt trauma. Patients were randomly allocated into control and experimental groups. Protocol was standardized for the control group. The experimental group had only the addition of the filter. Films were assessed independently by two consultant radiologists, blinded to whether they were from the control or the experimental group. Radiologists recorded visualization of the upper border of T1. Adequacy in other regions and the need for a Swimmer's projection was assessed. RESULTS: The first 80 films resulted in a statistically significant increase of 31% in visualization of the C7/T1 junction using the filter. Subjectively, overall adequacy was not compromised. There was a lower request rate for Swimmer's projections. Data collection is still in progress. CONCLUSIONS: In the sample so far, this simple technique has improved the visualization of C7/T1 on the initial cross-table lateral film, without compromising overall adequacy. The potential for reduction in additional projections has been demonstrated. Trials in other centres are recommended.

1415
An analysis of cervical spine imaging after trauma
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This study concentrates upon a comparison between trauma imaging procedures in Canadian and UK hospitals. It reviews how systems of work are adapted to meet the needs of the incapacitated patient. The study concentrates upon the equipment used, projections undertaken and photographic considerations required for imaging the cervical spine of an incapacitated trolley patient. An evaluation of the equipment is carried out in the light of central features of trauma imaging systems, derived from literature and by observational study. Photographic requirements are analysed in the same manner. Differences between UK and Canadian image series are highlighted and discussed in the light of literature and interviews. Conclusions drawn suggest and justify the limitation of the Canadian cervical spine imaging series and suggest further central features when considering a trauma imaging system.

1425
Testicular cancer and the feasibility of a screening programme for the disease
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Testicular cancer is the most common solid tumour in males aged between 16 and 34 years. It accounts for approximately one in every seven deaths occurring amongst late adolescent and young adult males. 95% of males are unaware of their risk of testicular cancer and indeed the techniques of testicular self-examination. Fortunately, early detection of the disease substantially increases survival rates. There is widespread knowledge of the "Well-women" clinics in the United Kingdom for both breast screening and cervical smear tests. These clinics provide information, counselling and screening programmes for the female members of the public. Why should men not have equivalent services provided for male health related diseases? Through an extensive literature review, this study addresses the issues of the epidemiology, aetiology and treatment strategies for testicular disease. In conjunction with this, it demonstrates the impact of testicular cancer diagnosis on a patient and his family. As controversy surrounds the topic of testicular cancer screening, 50 postal questionnaires were employed to ascertain the attitudes of Northern Ireland's general practitioners (GPs) towards screening for the disease. The survey concluded that 100% of GPs do not routinely include examination of the testes during routine physical examination of males within the age risk group. The study concluded that it would be more feasible to limit screening to "high risk" groups, *i.e.* men born with undescended testicles.

1435
The feasibility of the posteroanterior projection in mobile chest radiography on the coronary care unit
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PURPOSE: To assess the feasibility of the posteroanterior (PA) projection in bedside chest radiography on the coronary care unit (CCU) of Macclesfield District General Hospital, and to compare radiographic quality of the PA films produced with a randomly selected, retrospective group of anteroposterior (AP) films. MATERIALS/METHODS: Radiographers were asked to position patients for PA films where possible on the CCU. Following all examinations, a questionnaire was completed, recording patient details and other information relevant to the examination. The quality of the PA films obtained was assessed by a radiologist, a senior radiographer and a student radiographer and compared with the quality of the retrospective group of AP films. RESULTS: Little difference was found between the number of patients positioned PA and AP during the study. No significant difference was found between the radiographic quality of films produced in the different positions. An analysis of variance found no significant difference in time taken for either projection. The PA projection was better tolerated by the patient and was more desirable than the AP as regards radiation safety. The main reason for the use of the AP projection was the patients' poor condition, although the AP films assessed were significantly less rotated and a deeper inspiration was achieved. CONCLUSION: The PA projection of the chest in mobile radiography on the CCU was found to be feasible. Recommendations were made that the PA projection of the chest should be obtained on the CCU when the patient's condition allows, as a more accurate assessment of heart size can be achieved.

1445
Erbium filtration maintains abdominal image quality and reduces dose
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The efficacy of erbium filtration as a dose-reducing technique is well documented. However, its effect on image quality is unclear. The current study investigates the dose-reducing properties of erbium filtration during plain abdominal radiography. Its cost-effectiveness and influence on image quality are also addressed. The radiation dose delivered using either the standard X-ray filtration (total: 3 mm Al equivalent) or 0.1 mm of erbium filtration added to the standard filtration was measured on an anthropomorphic phantom and 21 patients. The images were assessed using objective quality criteria as defined by the European Commission (EC). Significant reductions in entrance surface ($p=0.0001$) and effective dose ($p=0.0099$) were noted with erbium filtration (64.6% and 23.4%, respectively). No significant difference in individual image criteria or total image scores were noted when erbium was used together with the standard X-ray filtration. The cost per manSievert saved was £128. The findings clearly indicate that erbium filtration is a cost-effective method of dose reduction which maintains the quality of the image. The authors encourage more widespread adoption of this dose-reducing filter.

1455
Technetium-99m macroaggregated albumin is stable for clinical use, for up to 9 h post-reconstitution
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PURPOSE: An experimental piece of work was carried out to investigate the stability and therefore safe clinical use of Technetium-99m macroaggregated albumin, beyond the manufacturer's recommended time limit of 6 h. A previous study conducted by Cornford (1997) demonstrated the bound radiopharmaceutical to be stable in terms of radiochemical purity when used for 9 h post-reconstitution. However, the work was criticized at the British Nuclear Medicine Society Conference (1997) on the basis of the methodology (paper chromatography) used for the quality assurance. EXPERIMENTAL METHODOLOGY: Samples were drawn from three labelled MAA kits, at 2-hourly intervals during the course of the working day. Each sample was analysed using instant thin layer chromatography. The location of activity present was demonstrated using a gamma scanner. The radiochemical purity of each sample was calculated. RESULTS/CONCLUSIONS: The results indicate that $^{99}Tc^{m}$ MAA is extremely stable over a 9 h period when kept under the conditions stated in the manufacturer's data sheet. Highly satisfactory values for the percentage of radiochemical purity were obtained which were comfortably in excess of the 95% limit quoted by the manufacturer. By comparison, both paper and instant thin layer chromatography give results showing no significant differences when determining the radiochemical purity of $^{99}Tc^{m}$ MAA. It is safe to use $^{99}Tc^{m}$ MAA for up to 9 h post-reconstitution. This is both time- and cost-effective.

1505
Image quality *vs* radiation dose in computed radiography of the pelvis
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PURPOSE: Computed radiography (CR) using storage phosphor plates offers the advantage of wide linear dynamic range with post-processing capabilities, providing consistent image density independent of exposure. It is also commonly believed that a potential for dose reduction exists. However, with severe underexposure, sufficient noise and quantum mottle is introduced, rendering an image non-diagnostic. The proprietary software used for processing can considerably affect image appearance and may contribute to producing an optimal image at low exposures. This study was designed to evaluate the effects of dose reduction and digital processing on image quality, and to determine the optimum factors which give a diagnostic image at the lowest dose. MATERIALS AND METHODS: The CR system tested was the AGFA ADC70. Leeds test objects were used to provide a semi-objective measure of limiting spatial resolution and threshold contrast detail detectability. A pelvis phantom was used and subjectively scored based on the European Commission quality criteria for diagnostic radiographic images. Images were acquired at a range of tube voltages (70–102 kVp) and photon flux densities. These were interactively evaluated on a 1024^2 matrix monitor by a physicist and a radiologist, respectively. RESULTS: Data analysis is still in progress; however, preliminary reports indicate that dose reduction of up to 50% or more may be feasible when compared with a 400 speed class screen–film system.

1515
The effects of various protocols on absorbed radiation dose during coronal CT of the sinuses
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PURPOSE: CT has been proven to be invaluable when examining the paranasal sinuses. Common clinical indications are sinusitis, polyps, cysts and mucoceles. There are two protocols that can be undertaken — coronal and axial. The coronal view is the standard protocol whereas the axial is only taken in addition. The protocols are based upon the ALARA principle to minimize radiation dose whilst maximizing diagnostic image quality. AIMS: (1) To investigate the dose received by the lens of the eyes during a CT coronal sinuses examination. (2) To compare radiation doses received during CT sinuses examination in 10 hospitals using different departmental protocols. MATERIALS/METHODS: 10 hospitals in the South East of England were randomly chosen with no selection criteria. Tests were carried out on the CT scanners in these hospitals, using their adopted protocols for the CT sinuses examination. A skull phantom was used to simulate eye dose measurements using lithium borate thermoluminescent dosimeters (TLDs). The TLDs were scanned using the coronal sinuses protocol including the scanogram. This was done three times using the same TLDs in each hospital. RESULTS/CONCLUSION: No preliminary results are available as the TLDs are currently being analysed.

1525
The measurement of thyroid dose in occlusal radiography
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PURPOSE: The risks from dental radiation have been an important area of discussion. The purpose of this study was to look at how much radiation the thyroid gland receives in occlusal radiography. The thyroid gland is a radiosensitive organ that is often in the primary beam during this technique. The aim was to see if a lead thyroid collar would be beneficial in reducing the dose to the organ. If so, then why is it not used in common practice? Many believe that the exposures used in dental radiography are low, yet it is still presumed that they can cause changes to the somatic tissues. METHOD: A Perspex Rando phantom was used, with lithium fluoride thermoluminescent dosimeters (TLDs) taped at various points. A TLD was taped to each eye to gain the lens measurements. Two were taped inside the phantom at the level of the thyroid and two were taped to the outside of the phantom to represent the surface dose at the level of the thyroid. For each test a variable was changed, the beam configuration (round/rectangular collimators) and the use of a 0.5 mm lead thyroid collar. RESULTS: Awaiting readings from the Medical Physics Department. CONCLUSION: To be drawn following the results.

1535
A reflective analysis of an intraEuropean student exchange scheme for radiographers
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BACKGROUND: The Departments of Radiography at the University of Salford and Helskini IV College of Health developed a bilateral agreement through the Socrates Programme. The programme enables staff and students to exchange between the two institutions. As part of this programme, two Finnish students studied with the third year BSc Diagnostic Radiography students at the University of Salford for three months. During this period several weeks were spent on clinical placement in the Radiology Directorate at the Manchester Royal Infirmary. PURPOSE: To explain the Socrates initiative and assess the value of the student exchange scheme. METHOD: Each student kept a reflective diary which was updated on a daily basis. On completion of the exchange each student identified, through thematic analysis, the issues which they felt were important. Subsequent to this, through discussion between the students, common issues were identified. RESULTS: Differences between the Finnish and British radiographers' education and professions were noted. Differences in professional responsibilities were observed. Useful international contacts were made. Cultural differences were observed. English language skills were enhanced. An open minded approach to face different situations and cultures was developed. CONCLUSION: The experience of participating in an intraEuropean exchange scheme has multiple facets extending far beyond the formal curriculum. The experience was positive and broadened our understanding of professional and cultural issues.

1545
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1600
Debate with the President

STUDENT WORK

Posters

National Indoor Arena Concourse Area

Student

POSTER 1601

A review of the picture archiving and communication system (PACS) at a major teaching hospital

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AIM: To review the picture, archiving and communication system (PACS) at a teaching hospital in order to ascertain the key characteristics of image acquisition, retrieval and storage. OBJECTIVES: (1) To assess how the system is applied to clinical areas, *e.g.* wards, outpatient clinics, operating theatres. (2) To review the system performance, its benefits and limitations. (3) To obtain feedback from staff about the ease of interaction with the system. METHOD: A literature review was undertaken, combined with structured interviews and observational analysis. RESULTS: Evidence from both the study and the literature noted that staff found the system was efficient and effective. Although it was noted that there were both benefits of and limitations to the system, the study found that most limitations could be overcome with careful planning and extensive training. CONCLUSION: The system has obvious benefits for both the radiology department and the hospital, owing to the efficiency in acquisition and communication of the image. Initial costs may be a deterrent for some departments, but subsequent opportunities to save money owing to the system's efficiency may well alleviate the effect of this initial outlay. The opportunities for increased quality and enhanced patient care indicate that the system is worthwhile implementing.

POSTER 1602

A review of limb lengthening techniques

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AIM: To review procedures used in limb lengthening and measurement. OBJECTIVES: To investigate the rationale for the choice of measurement technique used for pre- and post-operative patients. (2) To evaluate the role of the radiographer within the multidisciplinary team. METHOD: An observational study of limb lengthening techniques in a major teaching hospital dedicated to children was undertaken. A review of the literature was undertaken combined with observational analysis of the organization and diversity of limb lengthening techniques. RESULTS: A combination of mechanical axis radiography and CT scannograms was found to be the most accurate and reliable method of measuring the limbs and assessing angular deformity. Orthogonal bone quality radiography, using a combination of imaging methods (conventional radiography, DXA and ultrasound), is used to assess the quality of bone growth at the distraction site. The radiographers observed are all seniors specializing in paediatric radiography and all undertake the complete range of examinations involved in limb length measurement. CONCLUSION: The pre-operative planning methods observed are the most reliable methods of assessment supported by the literature. Post-operative imaging has developed to enable accurate assessment of the distraction site by a variety of imaging techniques, displaying an innovative approach to radiation dose management. Radiographers are core members of the multidisciplinary team, using a variety of imaging methods to provide an accurate and efficient service.

POSTER 1603

The implications of changes in management policy on radiographers in a community hospital

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INTRODUCTION: It is recognized that the shift in emphasis from acute to primary care in the White Paper "The New NHS. Modern, Dependable" could have considerable implications for radiographers working in community hospitals. This paper seeks to outline the experiences of a hospital which changed focus from secondary to primary care in 1991. The implications of these changes to the radiology department and its staff in terms of the scope, nature and load of work are investigated. METHOD: A review of the literature was undertaken together with analysis of an observational study, structured interviews, informal discussion and departmental statistics. RESULTS: Four main areas were noted to be affected: (1) *Type of work:* Acute and theatre work was lost. More outpatient services and an ultrasound facility were gained. (2) *Number of staff:* Reduced from 3.4 to 2.4 whole time equivalents (WTE). (3) *Volume of work:* On-call figures were reduced by 66%. The total number of patients reduced by 20%. (4) *Nature of work:* A change from accident and emergency (44%) to geriatrics. CONCLUSION: Policy changes have had a considerable impact on the work of the radiographers, changing the nature of traditional roles. Such changes have brought about opportunities for role development and have also seen patients' perceptions of the service improve. The effects of change in this community hospital continue to have an impact and further study will be required to ascertain the likely effects in other similar units.

POSTER 1604

A comparison of stress in mammographers working in a regional department and mobile screening unit

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PURPOSE: The healthcare field has been noted to be a very stressful environment in which to work. Previous research has recognized that occupational stress can be found in many health professionals; however, few studies have explored possible stress in mammographers. The aim of this study was to examine occupational stress in mammographers, comparing a mammography department to a breast screening van environment. METHODS: A limited one shot survey was carried out on a total of 10 mammographers. A questionnaire and diary were used as data collection tools. A response rate of 100% was achieved. The Wilcoxon matched-pairs signed-ranks test was used to compare the causes and symptoms of stress in the mammography department and breast screening van. A level of 0.05 (5%) was accepted. RESULTS: Results showed no overall significant difference when comparing causes of stress ($p=0.5076$). However, stress caused by environment/work demand issues was found to be significantly higher in the department ($p=0.0166$). A significant difference was found when comparing symptoms of stress ($p=0.0166$), suggesting that they are greater in the department. Similar issues, related to causes and symptoms, were found to be causing most stress in both environments, for example, making mistakes and dissatisfaction. CONCLUSIONS: Limitations with the study suggest that the results should be treated with caution, although some findings can be supported by previous literature, suggesting that stress in mammographers may not differ greatly from that in other healthcare professionals.

POSTER 1605

The radiation dose received by healthcare professionals' eyes during a barium enema examination

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The purpose of the study was to investigate the radiation dose received by healthcare professionals' (HCP) eyes whilst present in the fluoroscopy room during a barium enema examination. Being a radiosensitive structure, the lens of the eye is susceptible to radiation damage, which may result in cataract formation. As routine monitoring of radiation dose received by HCPs' eyes is infrequently carried out, this area appeared to warrant investigation. Clinical practice was simulated using a whole body anthropological phantom to represent the patient during a barium enema examination, the radiation dose was measured in the four positions most commonly occupied by HCPs in the fluoroscopy room during such an examination. The results were extrapolated to show the radiation dose that would be received by the eyes in each HCP position, per examination and per year. Even though the findings showed that the radiation doses received in each position were below dose limits set by The International Commission for Radiological Protection, the investigation highlighted areas which should be avoided unless absolutely necessary. Practical ways in which the dose may be reduced were recommended.

POSTER 1606

The radiographic appearance of a cholecystocolic fistula as seen during a barium enema examination

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The study is of a patient with a cholecystocolic fistula diagnosed following a double contrast barium enema (DCBE) examination

carried out by a radiographer. The initial radiographic appearance of such fistulae, showing contrast media leaving the colon via an unexpected route during a DCBE, may mimic other more serious pathologies. Ways in which these pathologies may be differentiated are considered and analysis of the radiographs taken in this case is given. The rarity of such fistulae is debated, as is the usefulness of other imaging modalities in diagnosing them.

POSTER 1607

To shift or not to shift — a case study in out-of-hours working

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This project is a comparative case study of two radiology departments, one operating a shift system and one operating an on-call system. Impetus for this research came from first hand viewing of the difficulties involved in staffing a department which operates an on-call system, creating the question as to whether any viable alternatives exist. A literature review highlighted a shortage of literature directly relating to staffing a radiology department. However, the available literature helped the researcher formulate the hypothesis that a clear link exists between working long hours — in this case, on-call radiographers - and increased stress levels and lower job satisfaction. 16 semi-structured interviews were carried out on eight radiographers who work in a shift system and eight who work in an on-call system. Radiographers were selected at random from all grades. Provisionally, the results have highlighted a number of issues, notably when a shift system was first introduced, morale and job satisfaction appeared to fall dramatically if the selected system was chosen for cost saving reasons. However, if a system was selected (or subsequently modified) with relevance to a combination of budgetary and staff needs, radiographers believed themselves to be less stressed and having higher morale. In conclusion, the research suggests that, when considering new shift/on-call systems, staff at all levels should be consulted. Additionally, shifts/on-call should only be changed if demand changes/increases and not solely to cut costs.

STUDENT WORK

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