Scientific Programme Abstracts

Monday 23 May

9.00 – 12.00 noon

Workshop: New Imaging Modalities

Royal Hall

The application of MRI to monitoring brain function [Invited Review]

G M Bydder and J V Hajnal
The Robert Steiner MR Unit, Royal Postgraduate Medical School, Hammersmith Hospital, Du Cane Road, London, UK

Much interest surrounds the use of magnetic resonance (MR) imaging for functional neuroimaging and the technique may lead to a new era in neurosciences research. However, the observed effects are small and require subtraction and/or statistical analysis of baseline and activated images for their recognition. Movement of the subject between the acquisition of these two images may be correlated with the stimulus and can result in signal changes that are highly localized and closely resemble those generally attributed to brain activation. Movement of only a fraction of a millimetre may produce significant artefact. Physical restraint of the subject's head of conventional type reduces motion but does not control it to submillimetre level. Post-processing schemes for the correction of effects resulting from motion involves realignment of images to a fraction of a voxel. Special care is required in performing this in order to avoid corrupting the pixel intensity data and thereby producing spurious effects. Progress in characterizing and controlling these problems with the activation experiment will be reviewed.

Imaging free radicals by EPRI and PEDRI [Invited Review]

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Free radicals are defined as molecules with one or more unpaired electrons in their outer orbitals. They are involved in normal metabolism, and changes in their concentrations in the body have been associated with the pathogenesis of many diseases, including cancer, inflammatory disease, heart disease and many others. Methods of imaging free radicals in the body are therefore of great potential use in biology and medicine. As well as imaging these endogenous free radicals, it is possible to consider the imaging of exogenous, stable free radicals which might be injected as "contrast agents", perhaps targeted to specific areas. Free radicals can be detected directly by electron paramagnetic resonance (EPR), a magnetic resonance experiment on the molecule's unpaired electron. Several research groups are currently developing EPR imaging (EPRI); the techniques used are similar to those developed for NMR imaging, but EPRI is rather more difficult to implement because of the very broad EPR resonances and, in particular, requires the use of very strong magnetic field gradients. In Aberdeen we have developed an alternative method of imaging free radicals, based on a combination of EPR and standard NMR imaging. We call the technique proton electron double resonance imaging (PEDRI): an NMR image is collected in the usual way while the EPR resonance of the free radical is irradiated. The Overhauser effect causes an increase in NMR signal from regions of the sample containing free radicals, and these parts exhibit greater intensity in the final image. Both EPRI and PEDRI have been used to image the distribution of exogenous free radicals in small animals, and work is underway to apply both techniques to the imaging of naturally occurring free radicals. We are currently constructing a whole-body PEDRI imager for imaging free radicals in larger animals and, potentially, humans. This paper will review recent developments in both EPRI and PEDRI.

The clinical application and utility of infrared as a means of monitoring the human brain [Invited Review]

[1]D T Delpy, [2]S R Arridge, [1]M Cope, [1]A Duncan, [1]C E Elwell, [1]S J Matcher, [1]M Schweiger and [1]T Whitlock
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Near infrared (NIR) light in the 700–1100 nm range will penetrate tissue to a considerable degree, often enabling intact organs to be transilluminated, and changes in light absorption to be continuously monitored at the bedside. The NIR region contains absorption bands of clinical interest, in particular those of oxy- and deoxy-haemoglobin and cytochrome oxidase (the terminal enzyme of the respiratory chain). Measured changes in light absorption can be converted into corresponding changes in the concentrations of these compounds if the optical pathlength of the light in the tissue is known. Unfortunately, due to the considerable scattering of light by tissue, this pathlength is not equal to the geometric spacing between the light input and output points. However, the pathlength has been measured using ultrafast laser techniques and, for a given tissue, has been shown to be a near constant multiple of the input–output spacing. NIR spectrometers are now commercially available which can provide second by second monitoring of haemoglobin and cytochrome concentration changes at the bedside. These have mainly been applied to the monitoring of cerebral oxygenation and haemodynamics in the human adult, newborn infant, and the human fetus during labour. Methods have now been developed using the NIR data to enable cerebral blood flow and blood volume to be quantitated. Two technical developments of the NIR technique are now under way. The first is the development of a new generation of NIR instruments which can automatically measure optical pathlength in real time. The second is the development of software with which to reconstruct images of tissue oxygenation distribution from NIR data collected at multiple sites on the organ surface. This review will illustrate the range of data that can be monitored with currently available instrumentation, and outline the developments that are likely to take place over the next few years.

Electrical impedance tomography [Invited Review]

B H Brown, D C Barber, N D Harris, J M Campbell, A Morice and R H Smallwood
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Electrical impedance tomography (EIT) is a relatively new method of producing images of the electrical impedance of tissue. It depends upon applying a ring of electrodes to the skin and then making impedance measurements, by first applying low amplitude, high frequency currents to pairs of electrodes and then measuring the resulting electrical potentials from the remaining electrodes. The images which result have poor spatial resolution but they contain functional information and are obtained rapidly, without hazard and at relatively low cost. The technique is best at imaging changes in tissue impedance such as those which occur in the lung during respiration and in many organs during blood perfusion. A number of possible clinical applications have been investigated and some of these are described. This includes imaging of lung ventilation and the measurement of both gastric emptying and motility. EIT is still at the research stage and it can be expected that some improvements will be made in spatial resolution and the reliability of measurement. A particularly promising development is that of multifrequency EIT which should allow *in vivo* tissue characterization to be carried out.

Magnetic source imaging in healthy subjects and in neurologic patients [Invited Review]

J P Mäkelä
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The anatomic image of the living human brain, obtained by MRI, can be complemented by positron emission tomography (PET) or functional MRI (fMRI) images to illustrate stimulus- or task-related haemodynamic changes. These changes are triggered by neural activity, but the exact relation between the two is not clear. Magnetoencephalography (MEG) allows mapping of brain electric currents with good temporal and spatial resolution. Thousands of nearby neurons, acting synchronously, generate a magnetic field large enough to be measured outside the head. From the measured field one can calculate the location of the brain area activated by sensory stimuli, or producing spontaneous brain activity. The identified sources can be overlaid on 3-dimensional MR images of individual subjects. MEG measurements reveal changes in auditory evoked fields (AEFs) in stroke. AEFs recover after unilateral deafness due to acoustic neuroma operation. Instead of dampening, some somatosensory evoked field (SEF) deflections are enhanced in multiple sclerosis. In myoclonus epilepsy, giant SEFs are detected. Parkinsonian tremor dampens spontaneous magnetic activity from the somatomotor cortex. Besides localizing epileptic activity, MEG depicts its spread between hemispheres. Combining different imaging methods is beneficial in brain studies. MEG may assist in quantifying the contribution of neural activity to haemodynamic changes seen in PET and fMRI, which, conversely, may help to delineate more exactly the magnetic field source areas.

9.00 – 10.25 am

Gastrointestinal Imaging

Ripley Suite

9.00 – 9.25 am
Clinical disorders of gastrointestinal motility [Invited Review]
G W Stevenson
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Motility disorders of the alimentrary tract are a common cause of symptoms, but the symptoms are often similar to those of many other conditions. Radiology is usually helpful in diagnosis, or in raising the suspicion of a motility problem that can be characterized by another test. This review will cover oesophageal problems including reflux and disorders with too much or too little contractile power; biliary dyskinesia and the underlying normal physiology; irritable bowel; hypopropulsive and hypopropulsive disorders of the small intestine; pseudo-obstruction; and some disorders of defaecation.

References

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9.25 – 9.33 am
Videofluoroscopy of the denervated stomach: a useful assessment of gastric emptying [Paper]
[1]A Quinn, [2]J McGrath, [1]F Wallis, [1]P Smiddy, [1]P Freyne and [2]T Walsh
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The post-oesophagectomy patient frequently has problems due to gastric emptying. Denervation of the stomach has a major role in this regard. We aimed to show, by videofluoroscopy of the stomach, that erythromycin can greatly enhance intrinsic peristalsis in the post-oesophagectomy stomach. 16 patients were studied, all at least 3 months after the operation. A group of them had clinically delayed gastric emptying. All patients had videofluoroscopy fasting, post-prandial and post-erythyromycin. The subsequent videos were analysed subjectively, and objectively with an image processing unit. There is a significant delay in gastric emptying in the post-oesophagectomy patient. The peristaltic waves which occur in the denervated stomach are greatly enhanced by erythromycin. We find that videofluoroscopy is a useful investigation for monitoring gastric emptying in post-oesophagectomy patients. In particular, the ability of the stomach to empty can be assessed. Erythromycin greatly enhances the intrinsic peristalsis of the denervated stomach.

9.33 – 9.41 am
Barium meal audit: who, why and how good? [Paper]
P A Hulse and D A Nicholson
Department of Radiology, Hope Hospital, Eccles Old Road, Salford M6 8HD, UK

Despite the introduction of open access upper gastrointestinal endoscopy in Salford in April 1993, the number of

referrals for double contrast barium meals has risen. A prospective study of 123 consecutive barium meals was performed. The age and sex of the patients, reason for and source of referral, and adequacy of the examination were examined. Clinical information from the request card was compared with that from a patient questionnaire. The examining radiologist and a consultant gastroenterological radiologist each scored the examination films with regard to adequacy of mucosal coating and distension. There was an even age (15–89) and sex distribution. Less than 1% of the referrals were from gastroenterological physicians or surgeons, 34% from other hospital specialists and 65% from general practitioners. 92% had good, 6% moderate and 3% poor indications. Request cards agreed with questionnaires in all but seven cases. 53% of examinations were performed by trainees and the remainder by a consultant radiologist. 50% were deemed inadequate, the commonest reasons being failure to record sufficient images and omitting the use of muscle relaxant. The significance of these results and implications for improving the service are discussed.

9.41 – 9.45 am

The impact of screening dose in the use of conventional radiography versus 100 mm photofluorography in barium meal examination [Poster]

A S K Dzik-Jurasz and N W Garvie
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We determined what proportion of the total dose delivered during a barium meal examination is attributable to screening, and the implications for the use of photofluorography as against conventional radiography. A set of three thermoluminescent dosemeters (TLDs) were positioned randomly over a variable thickness of tissue-equivalent blocks. These were irradiated for different periods of time to simulate fluoroscopic screening. Separate numbers of exposures using both imaging methods were carried out to simulate radiograph or 100 mm film exposure during examination. Assumptions of screening times and number of films taken are based on data previously gathered in our department. Assuming a mean of 8.2 conventional radiographs per barium meal, then 83% of the total dose of an examination is attributable to screening. With a mean of 18 images using 100 mm photofluorography, then 69.7% of the total dose is due to screening. The ratio of doses to exposures alone for the two methods is 2.25% in favour of conventional radiography. If the screening dose is added, this ratio falls to 1.2. It is generally assumed that the dose to the patient is decreased if photofluorography is used rather than conventional radiography in studies of the upper gastrointestinal tract. Our results suggest that this is not always the case, added to which most of the dose received by the patient is due to screening, and an advantage gained by either method is negated by the dose attributable to screening.

9.45 – 9.53 am

The use of water-soluble non-ionic contrast agents for small bowel follow-through examinations [Paper]

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Examination of the small bowel with water-soluble contrast medium is indicated in obstruction, suspected perforation, or barium intolerance. Examinations between 1987 and 1993 were reviewed. A standard technique was used, with 100 ml of oral iohexol 350 mg ml^{-1} and abdominal radiographs with fluoroscopy as required. Radiographic quality, adequacy of anatomical detail and the presence/site of pathology were recorded, and correlated with operative findings/outcome. 52 examinations were performed on 42 patients. The indications were: postoperative obstruction/prolonged ileus (23 examinations/21 patients), total parenteral nutrition (13/10), possible perforation/obstruction (8/8) and barium intolerance (8/4). One patient had two examinations for different indications. Obstruction was demonstrated in 12 studies and the site identified radiologically, confirmed in 6/7 laparotomies. Fistulae were identified in 11 examinations, and the radiological findings confirmed in all eight cases where laparotomy was performed. The entire small bowel was examined in 21 patients (with no history of small bowel resection): good radiographic contrast and demonstration of anatomical features was obtained to the terminal ileum in 19/26 examinations (73%). Relatively small volumes of non-ionic contrast agents have been shown to produce good opacification in the small bowel, allowing accurate radiological diagnosis in patients where barium suspensions are contraindicated.

9.53 – 10.01 am

MR imaging of small bowel Crohn's disease [Paper]

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We aimed to develop an alternative to repeated small bowel enteroclysis in the management of patients with established Crohn's disease. 500 ml of a 50% fat emulsion is given orally 45 min before scanning and Buscopan 40 mg iv administered immediately before scanning; axial and coronal T_1-weighted images are taken of the whole abdomen. This technique has successfully demonstrated the

small bowel disease in patients with Crohn's disease. It does not involve irradiation or intubation and requires only 15 min of scanning time. It has been well tolerated and patients prefer it to enteroclysis.

10.01 – 10.05 am
Pseudomembranous colitis (PMC): diagnostic sensitivity of the abdominal plain radiograph [Poster]
G W Boland, M J Lee, A M Cats and P R Mueller
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PMC is produced by toxigenic strains of *Clostridium difficile* with a wide clinical spectrum of disease ranging from asymptomatic cases to severe colitis, which can be fatal. We performed a retrospective study to determine the incidence of plain radiographic abnormalities across the range of clinical severity, reviewing 152 plain films of the abdomen (taken within 3 days of PMC diagnosis) from 138 patients with PMC. Plain film abnormalities recorded included small and large bowel ileus, ascites, nodular haustral thickening and toxic megacolon. 48/152 (32%) plain films demonstrated abnormalities, including colonic ileus 48/152 (32%), small bowel ileus 31/152 (20%), ascites 10/152 (7%), nodular haustral thickening 28/152 (18%) and toxic megacolon in 10/152 (7%). The distribution of colonic ileus in the 48 affected patients included: right colon 41/48 (86%), transverse colon 35/48 (72%), left colon 26/48 (55%). Distribution in 28 patients with nodular haustral thickening included: right colon 5/28 (18%), transverse colon 15/28 (54%), and left colon 14/28 (50%). PMC produces a wide spectrum of plain radiographic findings which occurred in 32% of patients. Characteristic changes indicating PMC were demonstrated in only 18%.

10.05 – 10.09 am
An audit of barium enemas in patients over 70 years of age — single or double contrast? [Poster]
R S Davies, T A Houghton, H E Lewis-Jones and B E Eyes
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A double-contrast barium enema technique is now the standard method for examinations of the large bowel. However, in elderly patients technical limitations such as poor retention of barium and air, and patient immobility, can adversely affect the quality of images obtained. In such cases a single-contrast study may provide adequate diagnostic information. A retrospective audit of all the enemas performed in the preceding year was carried out. 35% were performed on over-70s and 50 of these were analysed by two radiologists. Scores were assigned for success of bowel preparation, distention with air, and detail obtained in each area of the colon. Then a prospective analysis of 50 enemas was performed using a double contrast technique in the under-70s and a single contrast technique in the over-70s. In the over-70s single contrast studies gave higher overall scores than double contrast studies, with a more uniform visualization of the colon, though there was some loss of the fine mucosal detail in the distal colon. In the elderly it may be preferable to use a single contrast enema technique, to produce more uniform visualization of the colon.

10.09 – 10.17 am
A blinded prospective trial of low residue versus normal diet in preparation for barium enema [Paper]
P G Kember, C S Tweed, K D McBride and M C Collins
Department of Radiology, Royal Hallamshire Hospital, Sheffield S10 2JF, UK

The aim of this study was to determine whether omission of low residue diet resulted in poorer preparation for barium enema. When their appointment was made, 300 consecutive out-patients were randomly allocated to have Picolax plus 3-day low residue diet, or Picolax alone. Both groups were matched in age, sex and current medication. The subsequent investigation was assessed blind by a consultant radiologist and graded for faecal residue, mucosal coating and diagnostic quality. No statistical difference was found between the two groups regarding amount of faecal residue, degree of mucosal coating or diagnostic quality. Disease distribution was similar in both groups. We conclude that a 3-day low residue diet is unnecessary in the preparation of patients for barium enema. Patients may simply continue with their normal diet up to the day before the investigation and then have standard purgative preparation.

10.17 – 10.25 am
Active steps in barium enemas — do we need them? [Paper]
R Farrow, D A Wallace, A M M Jones and J P Virjee
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The 24 h morbidity following double contrast barium enema (DCBE) examinations was examined to determine whether an active drainage technique would reduce patients' symptoms. 80 patients booked for outpatient DCBE examinations were randomly allocated to one of the four groups. Patients were examined using either CO_2 or air as the negative contrast agent; at the end of the procedure they either had no formal drainage or were actively drained of gas and barium. Patients were given a questionnaire for completion 24 h after the DCBE. There was no difference in age and sex distribution between the groups. The group

which had received air + passive drainage had significantly ($p < 0.05$) higher scores for pain (5.1) and swelling (3.2) than did the other groups. There was no significant difference in the pain and swelling scores between the air + active drainage, CO_2 + passive drainage and CO_2 + active drainage groups. Analgesia was most frequently used in the group which had air + passive drainage. There was no difference in image quality between the groups. If air is to be used for DCBE, active drainage should be employed to reduce pain and swelling. If CO_2 is available, drainage imparts no additional advantage and can safely be omitted.

9.00 – 10.29 am

Ultrasound

Harewood Suite I

9.00 – 9.25 am
Interventional ultrasound [Invited Review]
H Irving
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Abstract not received

9.25 – 9.33 am
Infertility: prostate ultrasound and antegrade ejaculatory ductography in the diagnosis of strictures in the genital tract [Paper]
D Rickards
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Male infertility due to obstruction to the genital tract can be treated by surgical means. Precise localization of the obstructing lesion is needed to determine correct surgical procedures. Vasography adequately demonstrated the proximal genital tract, but not the lower genital tract. 16 men are reported with evidence of obstructive infertility. Transrectal ultrasound (TRUS) demonstrated varying degrees of dilatation of an ejaculatory duct or seminal vesicle in all patients. Under TRUS control, the ipsilateral seminal vesicle was punctured perineally. Under TRUS screening, saline injected into the seminal vesicle could be seen to distend up the ejaculatory duct and detail the point of obstruction. Contrast medium was then injected and spot films taken. In all 16 patients, the exact site of obstruction was defined, which allowed precise surgical correction. This simple technique should be considered in those patients with evidence of obstruction to the lower genital tract.

9.33 – 9.41 am
Abdominal sonography in the evaluation of patients with abnormal viscero-atrial situs [Paper]
[1]K Oleszczuk-Raschke, [2]P A K Set, [1]H J von Lengerke and [3]J Tröger
Departments of Radiology, [1]Münster University, [2]University of Cambridge, Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ, UK, and [3]Heidelberg University Hospital

The various terms used to describe abnormal viscero-atrial situs reflect the complexity surrounding this congenital malformation of the cardiovascular and abdominal organs. As visceral malposition and dysmorphia are often associated with an indeterminate atrial arrangement, the determination of abdominal visceral and vascular anatomy forms an important part of the diagnosis of atrial isomerism. Real-time sonography with Doppler is well suited for the evaluation of abdominal visceral and vascular anatomy in the paediatric age group for several reasons: it is non-invasive, it poses no radiation risk, examination is possible without sedation and it is inexpensive. We present the abdominal ultrasound findings in 14 children with mean age of 2.5 years (range 4 days–10 years). We found 10 cases of left isomerism and four cases of right isomerism. We review all the imaging techniques used in the evaluation of heterotaxy, with emphasis on the role of abdominal ultrasound, with pulse and colour Doppler; we present some

typical and atypical abdominal vascular and visceral anatomy; and demonstrate some features not previously reported in the radiological literature. This provides a practical scheme for the radiologist when faced with the challenging task of evaluating abdominal visceral situs.

9.41 – 9.45 am
Ultrasound detection of intraperitoneal fluid [Poster]
S Peterson, M Braithwaite, J McCaig, J Varhese, M R Rees and S Davies
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Abdominal assessment is difficult in unconscious trauma victims. Diagnostic peritoneal lavage is invasive and non-specific. Ultrasound is portable, rapid and non-invasive and can detect and localize intraperitoneal blood, as well as retroperitoneal collections and in some cases visceral injuries. Patients in chronic renal failure with their first newly inserted peritoneal dialysis catheter, on the occasion of their first dialysis, were examined by ultrasound to assess the sensitivity of the method. Body mass indices (BMI) (kg^{2}) were assessed where possible to assess the effect of physique. Ultrasound examinations were performed: (1) before any fluid had been instilled, (2) after randomization to instillation of 100 ml or zero ml of dialysate infusion, and (3) after a second randomized instillation. Possible infusion volumes therefore ranged from 0 to 200 ml. The results were: no fluid instilled, scan negative: 2 patients; fluid instilled, scan positive: 5 (mean BMI = 29.62 kg^{-2}); fluid instilled, scan negative: 3 (mean BMI = 23.9 kg^{2}). All pre-randomization/pre-infusion scans were negative; all positive scans were positive after the first 100 ml; one false negative scan missed 200 ml. While larger numbers of subjects are required, ultrasound in slim adults appears to detect small amounts of intraperitoneal fluid and, when positive, avoids diagnostic peritoneal lavage. Ultrasound is unreliable in obese patients.

9.45 – 9.49 am
Lymph node anatomy [Poster]
[1]C Metreweli and [2]L Chan
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Lymph nodes have a gross histological structure that superficially resembles that of the kidney. There is a cortex and medulla and central hilar region with arterial and venous vessels and efferent lymphatic duct. In axilla and inguinal region there is also abundant hilar (or sinus) fat. This pattern is occasionally found elsewhere. Ultrasound can reveal many of these details *in vivo*. An understanding of normal appearances and variations with age and site is essential in order to be able to define the abnormal accurately.

9.49 – 9.53 am
Physiological splenomegaly! [Poster]
J D Hunter, S V Thorogood, R Uberoi, C Roobottom and P Dubbins
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The haematological and haemodynamic consequences of pregnancy are complex and it might not be surprising to find a corresponding change in spleen size. The aim of the study was to establish values for splenic size in the pregnant population using ultrasound, and furthermore to determine the magnitude and time course of any change. We recruited 30 pregnant volunteers, of gestational ages between 12–22 weeks. Their spleens were measured on recruitment and re-measured at 34–38 weeks. The volunteers had no past medical history of relevance and these were all normal singleton pregnancies. Spleen size increased significantly in 63% of our volunteers. In the remaining 27% there was no change. A significant proportion, 33% overall, had, in late pregnancy, a spleen size that would be considered pathological in the non-pregnant population. In conclusion, normal pregnancy is a cause of splenomegaly. An awareness of this phenomenon, which is presumably transient, is important and it should be borne in mind before necessarily implicating a second aetiology.

9.53 – 9.57 am
Ultrasonic assessment of hemidiaphragmatic movement in acute stroke [Poster]
J G Houston, A D Morris, K R Lees, I Bone and N McMillan
Department of Radiology, Western Infirmary, Glasgow G11 6NT, UK

We have recently described and evaluated a technique using ultrasound for the assessment of hemidiaphragmatic movement, in particular to define normal ranges of movement of each hemidiaphragm. Pneumonia on the hemiparetic side is a significant cause of morbidity and mortality in acute stroke. In rehabilitation, exercise endurance and respiratory function affect the recovery in these patients, and ipsilateral hemidiaphragmatic paralysis has often been cited as an underlying aetiological factor. In the early assessment of this technique, we studied 50 patients presenting with acute onset of hemiparesis (within 72 h), 25 right and 25 left middle cerebral artery (MCA) infarcts, and 50 controls

matched for age and sex, to determine if there is any evidence of hemidiaphragmatic paresis in acute stroke. All patients had chest X-ray, CT brain scan and diaphragmatic ultrasound. In neither group of hemiparetics was there any significant evidence of unilateral paresis, although both showed bilateral reduction in excursion, most marked in those with a left MCA infarct. In addition, ultrasound was found to be a simple non-invasive means of quantitatively assessing hemidiaphragmatic movement in patients on the ward.

9.57 – 10.05 am

Transabdominal ultrasonic detection of intraperitoneal adhesions [Paper]

H D'Costa, C Brown, R Uberoi and P Dubbins
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Bowel perforation during laparoscopic surgery is a serious complication, with bowel adherent to the anterior abdominal wall from adhesions particularly at risk. It has been suggested that transabdominal ultrasound can accurately predict the presence of intraperitoneal adhesions. To evaluate this further we carried out a prospective study in patients undergoing elective abdominal surgery. Normal visceral slide was assessed in 15 healthy volunteers, followed by a prospective study in 32 patients to detect and categorize adhesions before surgery. Visceral slide during spontaneous respiration (SRSL), with manual compression (MCSL) and exaggerated respiration (ESL) was assessed in all four quadrants. Volunteers demonstrated > 4 cm slide with ESL, > 1 cm mean SRSL and MSL in all quadrants. Adhesions were found in 34 quadrants in 14 patients at surgery. Reduced SRSL detected fibrous adhesions in 7/16 quadrants and 2/18 fibrinous adhesions (overall sensitivity 26%, specificity 89%, accuracy 73%). MCSL detected 11/16 fibrous and 6/18 fibrinous adhesions (overall sensitivity 50%, specificity 75%, accuracy 68%). ESL detected 10/16 fibrous and 4/18 fibrinous adhesions (overall sensitivity 41%, specificity 67%, accuracy 60%). Preliminary results suggest that transabdominal ultrasound is unreliable for the detection of intraperitoneal adhesions.

10.05 – 10.13 am

Ultrasound of cutaneous tumours with a 7.5 MHz probe [Paper]

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Much of the current use of ultrasound in dermatological practice involves the use of high resolution probes (20–50 MHz). This study aims to assess the use of a routinely available 7.5 MHz linear ultrasound probe with an inbuilt water-bath to examine cutaneous tumours. Non-ulcerated cutaneous tumours were scanned prior to surgical excision, and the ultrasonic appearances of a variety of cutaneous tumours were assessed. 45 tumours were scanned, of which 29 were basal cell carcinomas. 24 tumours had well-defined margins. Some small superficial tumours could not be detected on ultrasound, in particular some of the superficial spreading basal cell carcinomas. The majority of basal cell carcinomas were hypoechoic compared to adjacent tissue. Invasion of underlying cartilage was determined in tumours at appropriate sites. The ultrasonic pattern of cutaneous tumours varies and may point to their aetiology. Ultrasound was found to be useful in determining the character of the margin and in defining the depth of tumour invasion in many cases.

10.13 – 10.21 am

Ultrasound: a useful diagnostic modality in imaging of chronically draining sinuses [Paper]

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We proposed to evaluate the use of ultrasound in the imaging of chronically draining sinuses. 20 patients with chronically draining sinuses underwent low and high kilovoltage plain X-rays of the affected part and sonography of the affected and contralateral normal part using Toshiba Ultrasound Model SSA-90A with a 7.5 MHz linear phased array transducer, followed by contrast sinography using Ultravist 300. We found that plain X-rays were useful in illustrating radiopaque foreign bodies in two cases (but five non-radiopaque foreign bodies were missed); they also showed the bony changes of osteomyelitis in seven patients. Ultrasound showed: all seven foreign bodies (non-radiopaque and radiopaque) with exact localization, depth and size; the whole sinus tract; evidence of soft-tissue abscesses with precise localization and exact size in six cases; evidence of osteomyelitis and subperiosteal abscess, with precise extent and localization, in seven patients. Contrast sinography delineated the sinus tract but foreign bodies were missed; the size of soft tissue abscesses and extent of subperiosteal abscesses could not be evaluated exactly; and this method involved contrast agents and ionizing radiation. We conclude that ultrasound is a simple imaging modality for examining details of chronically draining sinuses, without using contrast agents or ionizing radiation. Ultrasound imaging of chronically draining sinuses may be termed ultrasonosinography.

10.21 – 10.29 am

Orbital ultrasound in Graves' disease of the thyroid [Paper]

B J McKeown, M Corbett, J Connolly and C Burnell
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We proposed (1) to establish a range of normal values for the ultrasound measurement of each orbital rectus muscle; and (2) to determine whether patients at risk of visual impairment from thyroid-associated eye disease can be picked up by ultrasound measurement of the muscles. 100 healthy volunteers and 67 patients with thyrotoxicosis underwent ultrasound examination and detailed ophthalmic examination, the examiners having no knowledge of the previous medical or ophthalmic diagnoses. The size of each rectus muscle was recorded and then correlated with the medical diagnosis and ophthalmic examination. Patients with previously diagnosed Graves'-associated eye disease (five patients) had significantly larger muscles than those in any other group ($p < 0.001$). Patients with Graves' disease but no established eye disorder (32 patients) also had larger muscles than both normal subjects and patients with non-Graves thyroid disorders (29 patients) ($p = 0.002$). Several of the patients with Graves' disease but no known orbital involvement had muscle sizes within or approaching the symptomatic range. These findings correlated well with the ophthalmologist's assessment of risk. The procedure could be used to screen patients with Graves' disease to detect those at risk of visual impairment, and to help distinguish Graves' disease from other forms of thyrotoxicosis.

9.00 – 10.16 am

Vascular Imaging

Harewood Suite II

9.00 – 9.08 am

Videodensitometric measurement of intra-arterial contrast media concentration during arteriography: a new technique [Paper]

[1]J G McNeill, [2]I A Castellano, [1]N A Chronos, [1]R H Stables and [1]N P Buller

[1]Department of Invasive Cardiology, and [2]Joint Department of Physics, [1]Royal Brompton Hospital (Chelsea) and [2]Royal Marsden Hospital (Chelsea), London SW3 6NP, UK

To date it has been difficult to quantify the concentration of contrast medium (CM) within the human coronary artery during arteriography. Non-ionic CM have been shown *in vitro* and *in vivo* to cause significant platelet activation at relatively low concentration. This may be considered to be a factor in enhancing intracoronary thrombotic processes at percutaneous transluminal coronary angioplasty (PTCA). We have utilized videodensitometry to correlate CM concentration to pixel grey level in 3 mm PTCA balloons filled at nominal pressure over a range of CM concentrations between 10% and 100% *in vitro*. These measurements were repeated over the range of X-ray beam energies used in clinical practice to generate calibration curves reflecting the change in pixel grey level due to changing attenuation coefficient at differing beam energies. The intracoronary 3 mm balloon at PTCA is filled with a 50% concentration of CM. The corresponding pixel grey level for this balloon was used, in conjunction with the calibration curve obtained at the same X-ray beam energy, to calculate the intracoronary CM concentration during arteriography. This novel approach has enabled us to demonstrate that, for non-ionic CM, the intracoronary CM concentration is above that which causes more than 80% platelet degranulation.

9.08 – 9.16 am

How much variation exists in the type of agents used during angiography or angioplasty in the United Kingdom? [Paper]

D M A Jackson and P Dawson

Department of Diagnostic Radiology, Hammersmith Hospital, London W12 0HS, UK

A questionnaire was sent to radiologists and cardiologists in the United Kingdom requesting information on their current practice as regards contrast agent choice and the use of heparin and other pharmaceuticals during diagnostic angiography and angioplasty. 200 replies (58.3%) were received, 62 (48%) from cardiologists, 138 (62%) from radiologists. A large amount of data was obtained. Briefly in diagnostic angiography 81% used non-ionics routinely; the remainder used a conventional ionic agent, unless contraindicated, or Hexabrix (ionic dimer). Perceived contraindications varied widely but few took Hexabrix to be equivalent to the non-ionics in high risk cases. Corticosteroid prophylaxis was used for a variety of indications by 58%. Flush solutions were heparinized (wide range of concentrations) by 76.5%. None added heparin to the contrast agent. Only 2.5% prescribed prophylactic aspirin. In angioplasty, 85% used non-ionics routinely and 15% conventional ionics or Hexabrix. Only a handful chose Hexabrix as the specific agent of choice for angioplasty. Again, 82% heparinized flush solutions using a range of concentrations and none heparinized any contrast agent. 82.4% used bolus heparin during the procedure with 73% adding aspirin as prophylaxis. 83.5% used long term prophylaxis, mainly aspirin. This snapshot of current thinking and practice in angiography will be presented in detail.

9.16 – 9.24 am

Interstitial non-ionic contrast lymphangiography [Paper]

G T Abbott, D Jamadar and D A Gould
Department of Radiology, Broadgreen Hospital, Liverpool L14 3LB, UK

Traditional lymphangiography requires cannulation of peripheral lymphatics, which can be time-consuming and difficult. Interstitial administration of a non-ionic water-soluble contrast agent is a recently developed technique which is relatively easy to perform and tolerable to the patient. We describe our experience with lymphangiography using intradermal Iotralan in 18 patients with clinically suspected lymphatic disease; this is a dimeric non-ionic contrast agent (Schering, Berlin). Four 25G butterfly needles, two around each malleolus, were placed intradermally in the affected limb and the Iotralan infused via a gravity feed cantilever pump system, delivering a flow of about 1 ml in 10 min. A total volume of about 7 ml was used; total infusion time was about 30 min. Radiographs were taken at 5 and 10 min using mammography film, and then at 15 min and at 5 min intervals thereafter using extremity film. Xeroradiography was performed in one case. All cases were outpatients. Normal subdermal lymphatics and vessels were shown in five cases. Primary hyperplastic lymphoedema was shown in four cases. Hypoplastic lymphoedema was shown in six cases, and subdermal lymphatic abnormalities in three. We conclude that interstitial lymphangiography using a non-ionic dimeric contrast agent allows structural assessment of subdermal lymphatics and vessels, and is of value in the diagnosis of lymphatic obstructive disease.

9.24 – 9.32 am

Evaluation of the Belfast DVT screener in suspected lower limb deep venous thrombosis [Paper]

S J Freeman, M Thornton, D Warwick, D Glew and A Mitchelmore
Departments of Radiology and Orthopaedic Surgery, Southmead Hospital, Bristol BS10 5NB, UK

This study was designed to test the accuracy and ease of use of the Belfast DVT screener in the detection of clinically significant deep venous thrombosis (DVT) of the leg. The clinical diagnosis of DVT is inaccurate in 50% of cases; venography is the standard investigation but is expensive, time-consuming and unpleasant for the patient. Plethysmography is sensitive in the detection of proximal DVT, but its use has been limited by lack of suitable equipment. The Belfast DVT screener is a computer-controlled strain-gauge plethysmography system, claimed to be simple to use and to have a high sensitivity in the detection of proximal DVTs. 94 patients referred for venography with clinically suspected DVT were tested with the Belfast DVT Screener before having a standard lower-limb venogram. We found the system easy to use. It gave a sensitivity of 100%, specificity of 57% and negative predictive value of 100% in the detection of significant DVTs. Our results suggest that in symptomatic patients a negative test excludes a significant DVT. In these patients a venogram may be unnecessary, and this would lead to a significant reduction in cost and discomfort for the patient.

9.32 – 9.36 am

Ongoing experience in the radiological placement of right atrial catheters [Poster]

[1]F Wallis, [2]C McMahon, [1]A Quinn, [1]D Kidney, [2]S McCann and [1]M Molloy
Departments of [1]Diagnostic Imaging and [2]Haematology, St James's Hospital, Dublin 8, Ireland

This was a prospective study to ascertain the safety and feasibility of placing large triple-lumen right atrial catheters under local anaesthetic in our Radiology Department. We placed a total of 54 right atrial catheters (RAC) over a 1-year period. 44 of these were triple-lumen 13F Quinton catheters, two were 13F Permacath catheters for aphoresis and eight were 8F triple-lumen catheters. All except one were successfully inserted. Patients had a variety of haematological disorders, and an age range of 17–75 years. Three catheters were inserted into HIV^+ patients. Many of the patients were thrombocytopenic or/and neutropenic at the time of insertion. To date we experienced only four serious complications related to the insertion (one line infection, one severe tunnel infection and two pneumothoraces), and noted 15 minor complications (minor haemorrhage, exit site infection responding to antibiotics). 12 patients had a second insertion, seven via their indwelling catheter. We conclude that the method of choice for insertion of RAC is now radiological under local anaesthetic. Insertion of larger catheters brings no increase in complications and is of great benefit to the patients.

9.36 – 9.44 am

Morbidity and acceptability of day-case angiography using 5 French catheters [Paper]

F Jewell, S Walsh, P Murphy and A J Jones
Department of Clinical Radiology, Bristol Royal Infirmary, Bristol BS2 8HW, UK

An audit of day-case angiography using 5F catheters was performed to assess acceptability to patients and to identify complications that may have been overlooked by early discharge from hospital. A questionnaire was sent retrospectively to each patient undergoing day-case angiography

in 1992. An 83% response rate permitted analysis of 113 procedures. Further information was gained from radiological reports, case notes, general practitioners and direct contact of patients by telephone. The level of patient satisfaction was high. Only one unexpected complication was uncovered and overall morbidity was low. It is concluded that morbidity from day-case angiography using 5F catheter systems is low and recourse to smaller catheter systems is unnecessary.

9.44 – 9.48 am

Buhler's arc: a rare congenital vascular anomaly [Poster]

A Benincasa
Radiologia Vascolare ed Interventiva/Servizio di Radiodiagnostica, Ospedale Mauriziano "Umberto I", 10128 Torino–Corso Turati 62, Italy

This paper concerns an occasional finding of a congenital anomaly of the coeliac trunk (CT) and superior mesenteric artery (SMA). During angiography of a patient with multiple hepatic nodular lesions, probably of a primitive heteroplastic nature, simultaneous opacification of the CT occurred during mdc injection in the SMA through a vessel morphologically normal and unrelated to pathological masses in the surrounding organs. During embryological development, the truncus arteriosus splits into the right and the left branches to form primitive descending aortas that, later, fuse to form the definitive aorta. Meanwhile, there are many ventrally anastomized aortic branches, some of which atrophy, and some form collateral aortic (epiaortic, intercostal, visceral, iliac) vessels. Then, it can happen that the anastomosis between the 10th and 13th roots doesn't atrophy but persists, becoming a direct pathway between the CT and the SMA, named Buhler's arc. This pathway can be beneficial to the patient as it maintains arterial flow in the CT and SMA in case of obstruction of one of these vessels.

9.48 – 9.56 am

Use of carbon dioxide as a contrast agent for intra-arterial digital subtraction angiography [Paper]

S W Yusuf, S C Whitaker, D C Hinwood, R H S Gregson, M J Henderson, P W Wenham, B R Hopkinson and G S Makin
Department of Radiology and Department of Surgery, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH, UK

A pilot study to evaluate the use of carbon dioxide (CO_2) as a contrast agent for intra-arterial digital subtraction angiography was prompted by the successful use of CO_2 for angiography/angioplasty in a patient with known allergy to contrast medium. Injection of CO_2 has been shown to be safe even in large volumes in both animals and humans. The relatively small volume of CO_2 required to obtain images is rapidly eliminated by diffusion into red cells and dissolution in plasma. Ethical committee approval and informed patient consent were obtained. 50 ml of medical grade CO_2 was hand-injected each time via a catheter in the common or superficial femoral artery. We carried out 10 studies in nine patients (eight angiograms and two angioplasties). In seven angiograms both CO_2 and Iopamidol were used. Arterial blood gases were obtained immediately before and after angiography. The images were independently assessed by a consultant vascular radiologist who was unaware of the contrast medium used. No significant side-effects were observed and there was no change in the blood gas parameters. In all paired angiograms, the independent assessor chose the Iopamidol images as being of better quality. Using these as the gold standard, 77% of all vessels on the CO_2 images were considered to be adequately visualized. CO_2 has advantages over non-ionic contrast medium, particularly in situations of allergy and cardiac or renal failure and in terms of cost. Further evaluation is in progress.

9.56 – 10.04 am

Vascular calcification in non-diabetic renal transplant recipients: does it matter? [Paper]

P Hession, G Avery, J P Owen, R Wilkinson and M K Ward
Departments of Radiology and Renal Medicine, Royal Victoria Infirmary and Freeman Hospital, Newcastle upon Tyne, UK

Vascular calcification is common in patients with end-stage renal failure but is thought to be asymptomatic. There are reports of serious complications and it has been shown in diabetics that vascular disease prior to transplantation is associated with increased mortality. We present a study to evaluate whether vascular calcification demonstrated by serial skeletal surveys had any influence on morbidity and mortality. 87 non-diabetic renal transplant recipients (54 M, 33 F) aged 14–66 years (mean 38 years) were followed up for 2–10 years (mean 7.85 years). 18 patients had no evidence of vascular calcification, 54 developed calcification after the transplant and 15 had calcification before transplantation which persisted. Between-group analysis was undertaken in patients without, and all patients with, vascular calcification. There were no differences between groups in respect of sex or age range, though the mean age of patients without calcification (25.2 years) was younger than of those with calcification (41.56 years). Patients with vascular calcification had more systemic vascular disease ($0.01 > p > 0.001$), particularly angina and peripheral

vascular symptoms. There were no differences between groups in respect of deaths, transplant non-function, hypertension, smoking history or family history of vascular disease. Skeletal surveys are useful for identifying patients at risk from vascular disease.

10.04 – 10.08 am
Arterial insufficiency of the ipsilateral leg in renal transplantation: implications and management [Poster]
W L Teh, C M P King and J E Dacie
Department of Diagnostic Radiology, St. Bartholomew's Hospital, London EC1A 7BE, UK

Renal transplant patients are at increased risk of atheromatous disease. Many factors contribute to this, including hypertension, diabetes mellitus, unfavourable lipid profile and prolonged haemodialysis. Pre-existing vascular disease is associated with a lower rate of graft survival, and atherosclerosis may be accelerated following successful transplantation. The problem is accentuated because more and more older patients and diabetics now undergo renal transplantation. We describe three patients (all men, aged 51–60) with a renal transplant who have been investigated for ipsilateral leg ischaemia. Two were shown to have a stenosis of the external iliac artery proximal to the renal transplant anastomosis, and were successfully treated by percutaneous transluminal angioplasty with no angiographic evidence of recurrence after 2 years. The other patient had distal occlusion and underwent femoro-femoral by-pass grafting. In patients with functioning renal transplants, symptoms of arterial insufficiency in the ipsilateral leg should be investigated urgently because proximal iliac stenoses potentially threaten graft survival.

10.08 – 10.12 am
Angiographic assessment of peripheral vascular disease in South Asian males compared with non-Asians [Poster]
A Padhani, J Curtin, R Wilkins and J Reidy
Departments of Radiology, Guy's Hospital and Northwick Park Hospital, London, UK

We have documented the arteriographic patterns and severity of peripheral vascular disease in the lower limbs of 26 symptomatic Asian males and compared them with those in 57 age-matched non-Asian males, studied over the same period, and reviewed the risk factors of the two groups, by means of a retrospective analysis of lower limb arteriograms without reference to ethnic origin, and hospital records of 83 symptomatic patients. All patients were referred from the vascular clinics of two large London hospitals with sizeable resident Asian populations. Asians overall were found to have a greater degree of claudication. Diabetes was the only risk factor associated with race, being more common in Asians (54%). There were no differences in the arteriographic scores between the two racial groups. The mean score for mid and distal disease was higher than for proximal disease in both groups. We concluded that there was no significant difference in the severity or distribution of atheromatous disease between Asian and non-Asian patients. The increased symptomatology amongst Asians is likely to be due to small vessel disease secondary to diabetes mellitus.

10.12 – 10.16 am
Peripheral angiography using the reverse shuffle technique [Poster]
J W Oxtoby, S Peterson, C Yeung, D West and M R Rees
Department of Imaging, North Staffordshire Hospital/School of Postgraduate Medicine, Stoke-on-Trent ST4 7QB, UK

Having carried out an audit into the film usage and the number of "runs" required to complete a standard peripheral arteriogram, we have found that in 30% of examinations multiple runs are required to complete the examination. In order to deal with this problem we have developed a simple technique to allow for imaging differential blood flow in the limbs when carrying out peripheral angiography. This technique, termed the "reverse shuffle", is carried out on a standard stepping angiographic table with an overcouch tube. After an intraarterial injection of 80 ml of contrast medium at a rate of 10 ml s^{-1} into the distal abdominal aorta, six films 14 × 14 inches are taken. The first film is taken over the pelvis, the second over the upper thigh and the third and fourth over the knees and calves respectively as in a normal angiographic sequence; the table then undergoes reverse movement to take a further film over the knees and then moves down to take a final film over the calf area. Using this technique in an unselected series of 20 patients, we have been able to complete satisfactory angiograms in 19 (95%). In four of the examinations, significant information was detected on the reverse shuffle film. We conclude that this simple angiographic technique allows for consistent peripheral angiography, with consequent film and contrast savings.

9.00 – 10.09 am

Radiotherapy for Head & Neck Cancer: Current Approaches

Bramham Suite

9.00 – 9.25 am

Planning a clinical oncology department [Invited Review]

P J D K Dawes
Northern Centre for Cancer Treatment, Newcastle General Hospital, Newcastle upon Tyne NE4 6BE, UK

The provision of investigation and treatment facilities for the non-surgical treatment of cancer is expensive. It also takes time to build and such facilities have a long life. It is important, therefore, that a department be designed to match the needs of its catchment population for many years. Major changes to such facilities may only take place once every 30–50 years. This talk will discuss the need for accurate information about the population to be served and its needs. It will briefly outline the personnel needed to fulfil these needs and then deal with buildings and equipment. The relationship of one part of a department with another is examined and one way in which improvements can be implemented is presented. This has resulted in considerable improvements to patient care and convenience as well as improved working practices. The conversion of a ward to an outpatient day case facility is also discussed and how this can be achieved relatively simply. In conclusion, an estimate of personnel and time needed to develop the plans will be attempted. In particular, those parts of the process which are the province of oncologists will be differentiated from those which are the province of construction experts.

9.25 – 9.33 am

Accuracy of treatment in a conformal radiotherapy trial: a prospective analysis of 90 patients [Paper]

R A Huddart, A Nahum, A Neal, M Law, J Dyer and D Tait
Departments of Radiotherapy and Physics, Royal Marsden Hospital, Sutton, Surrey SM2 5PT, UK

Conformal radiotherapy aims to reduce toxicity by minimizing the volume of normal tissue irradiated. To achieve this the treated volume must accurately represent the planned volume. In a trial of conformal therapy we have prospectively assessed the accuracy of such treatment by taking weekly anterior and lateral portal films. On completion of treatment, the displacement of the field centre from defined reference points on each film was measured. Summary statistics for overall simulator–film differences and mean treatment position *vs* simulator position will be presented. Overall only 39% of treatments kept within a 0.5 cm threshold, with 67% and 55% of anterior and lateral fields being treated accurately. 10% of treatments had at least one 1 cm error. 41% of patients had an error of at least 0.5 cm in one field in over 80% of their treatments. Increasing weight significantly increased the risk of introducing systematic errors in the superior inferior direction, as did weekly versus daily treatments for the right/left measure. In summary, a significant proportion of treatments have errors of over 0.5 cm, particularly in the lateral fields. This is due to both systematic and random errors. Adequate allowance needs to be made for this when planning conformal therapy. Improved patient immobilization and/or treatment verification may improve the efficiency and safety of conformal treatments.

9.33 – 9.41 am

Hyperfractionated radiotherapy of tumours in the cavity of the mouth and the oropharynx [Paper]

M Niewald, K Schnabel, A Koch and W. Berberich
Department of Radiotherapy, University Hospital of the Saarland, D-66421 Homburg/Saar, Germany

We tried to find out whether hyperfractionated radiotherapy of ENT cancers is beneficial as regards local tumour control, survival and side effects. 112 patients were irradiated with single doses of 1.2 Gy applied twice daily up to a total dose of 82.8 Gy in 7 weeks. The supraclavicular lymph nodes were treated up to a total dose of 55.2 Gy with the same fractionation. 71% had been operated on before, 29% had no pre-treatment. Results for this group were compared with those for a historical one of 231 patients

who had been irradiated conventionally (single dose 2 Gy once a day, total dose 70 Gy in 7 weeks; figures in brackets). The local control result was: CR in 55% (57%), PR in 13% (7%), NC in 1% (2%), PD in 29% (25%) ($p = 0.026$). The mean empirical survival was 765 days (930 days, NS), the mean progression-free interval 682 days (849 days, NS). The 5 year survival was 37.1% (35.2%, NS). Mucositis ($p < 0.001$), sialadenosis ($p = 0.001$) and mucosal necroses ($p = 0.006$) were more frequent in the hyperfractionated group. Prognostic factors for survival were Karnofsky status, T and N classification, localization and pre-treatment ($0.001 < p < 0.01$). We concluded that in such cases hyperfractionated radiotherapy was no more beneficial than conventional radiotherapy. The increase in acute and late side effects can be explained by a biological overdosage of the hyperfractionated schedule compared to the conventional one.

9.41 – 9.49 am

Response of supraglottic tumours of the larynx to radical radiotherapy [Paper]

[1]A G Robertson, [2]C Robertson and [3]T Wheldon

[1]Beatson Oncology Centre, Western Infirmary, [2]Department of Statistics and Mathematical Modelling, University of Strathclyde and [3]Department of Radiation Oncology, Garscube Estate, Glasgow, UK

From a database of 965 patients, 163 were identified as having squamous cell carcinomas arising in the supraglottic region. 100 of these had no nodal involvement. Only 54 patients from this group were identified as having stages T1–T4 with no nodal involvement, and had been treated on a cobalt machine or a linear accelerator and been followed up for 5 years. Patients were treated by one of six regimes: 60 Gy in 25 fractions over 35 days; 60 30 42; 60–15–35; 60 30 42+; 55–25–35; 54–18–42. The results have been analysed: survival curves were constructed to estimate local control results, and LQ analysis has been carried out. The results show that for T1 lesions the use of a beam-directed shell improved survival, and, as effective doses increased, so did the chances of obtaining real control. Equally, as treatment time lengthened, the ability to achieve local control decreases. Results for more advanced tumours — T2, T3 and T4 — are less clear-cut, although, again, as treatment time increases, the chance of achieving local control decreases and an increase in effective dose increases the chances of achieving local control. For T1 lesions the 5-year local control rates are as follows: 60–25–35, 33%; 60–30–42, 48%; 40 15 21, 100%; overall 54%.

9.49 – 9.53 am

Carcinoma of the larynx: results of radiotherapy and surgery in 116 patients [Poster]

M Portaluri, V Fusco, S Parisi, A Raguso, P Corsa, M Troiano and P G Paleani-Vettori

Radiotherapy Department, IRCCS Ospedale Generale Ragionale "Casa Sollievo della Sofferenza", 71013 San Giovanni Rotondo (FG), Italy

Survival, pattern of recurrence, tumour control probability and complications probability are analysed in 116 patients affected by larynx cancer, treated between 1985 and 1990. 61 underwent irradiation alone (mean age 67 years, mean total dose 63.5 Gy, median follow-up 40 months); 55 underwent surgery and radiation (mean age 62 years, mean total dose 59 Gy, median follow-up 48 months). Actuarial survivals are calculated by the Kaplan-Meier method, tumour control probability dose (TCP) by Porter's calculation and complication probability dose (CPD) by logistic linear regression. 5-year survival figures for radiotherapy alone: T1–2 N0 92.6%; T3–4 N0 43.3%; T1–2 N+ 44.4% (4 years); T3 4 N+ 20%; for postoperative radiotherapy: T1–2 N0 89.5%; T3–4 N0 58.3%; T1–2 N+ 50% (4 years); T3–4 N+ 37.7%. In the T3–4 N0 group, the TCP_{50} is 58 Gy if the radiotherapy alone is concluded within 50 days, 67.5 Gy if the treatment lasts more than 50 days. Late complications occurred in 11/37 patients treated with two lateral fields (LL) *versus* 9/21 patients treated with anterior direct field. The CPD_{50} for the direct-anterior field group is 62.5 Gy versus 68.1 Gy in the LL group. In T3–4 N0 patients, overall treatment time affects the outcome. A better therapeutic ratio is obtained when LL fields are employed in neck irradiation.

9.53 – 9.57 am

Cancer of the floor of mouth treated by surgery with or without post-operative radiotherapy [Poster]

[1]S Ageli, [1]A G Robertson, [2]D S Soutar, [2]C Bainbridge, [2]G Scerri, [3]B Torsney and [3]V Hodge

[1]Beatson Oncology Centre, Western Infirmary, [2]Canniesburn Hospital and [3]Department of Statistics, University of Glasgow, Glasgow, UK

147 patients (116 males, 31 females) with squamous cell carcinoma of the floor of mouth treated at Canniesburn Hospital and the Beatson Oncology Centre between 1978 and 1991 were reviewed. 34 patients presented with a T1 tumour, 47 with a T2 tumour, 22 with a T3 tumour and 41 with a T4 tumour; 44 had nodal involvement at time of presentation and 103 did not. T1 N0 tumours and small T2 N0 tumours were treated by surgery alone. The rest were treated by radical surgery and post-operative radiotherapy. The 5-year survival for node-negative patients treated by

surgery alone was 90%, and the 5-year survival for node-negative patients treated by surgery and post-operative radiotherapy was in the region of 80%. Where there is nodal involvement, 5-year survival is 45%.

9.57 – 10.01 am

Medullary carcinoma of the thyroid misdiagnosed as differentiated thyroid carcinoma [Poster]

A M Moody, J Sharpe, C Fisher and C L Harmer
Thyroid Unit, Royal Marsden Hospital, Fulham Road, London SW3 6JJ, UK

Medullary cancer of the thyroid (MTC) may be mistaken for differentiated thyroid cancer as the latter is much more common, and poorly fixed MTC can have pseudopapillary features. The correct diagnosis is important as the management and prognosis of the two conditions are different. We have therefore evaluated patients from the Royal Marsden Hospital in whom a misdiagnosis was made to identify those features which should arouse suspicion. Four cases are presented who all had MTC but who were initially diagnosed and treated for differentiated thyroid cancer. All four patients received radioiodine with no uptake of isotope on diagnostic scanning, although three had clinical disease. Two cases were initially diagnosed as papillary and two as follicular cancer. In two cases the correct diagnosis was made when further histological material was available. In the other two cases the diagnosis was corrected on histological review of the original pathology. MTC may be mistaken for differentiated thyroid cancer unless careful review of those cases with atypical clinical or histological features is undertaken. This has resulted in expensive and potentially hazardous therapy, with radioiodine being administered to no benefit and a delay in correct treatment.

10.01 – 10.05 am

Prognostic significance of locoregional progression in patients with laryngeal cancer after irradiation [Poster]

M Niewald, H-J Tkocz, K Schnabel and W Berberich
Department of Radiotherapy, University Hospital of the Saarland, D-66421 Homburg/Saar, Germany

The influence of local recurrence, regional lymph node metastasis, or both, on the outcome of patients with laryngeal cancer was examined. 213 patients with primary laryngeal squamous cell cancer without distant metastases were irradiated using total doses mostly ranging from 60 to 70 Gy in 6–7 weeks (single dose 2 Gy). 36% had been operated on before, 12% had received chemotherapy, the remaining 52% had no pre-treatment. 15% of the patients had a local recurrence during follow-up, 3% a lymph node metastasis only, 10% had both. The others (72%) were free of loco-regional recurrence. The mean follow-up was 1106 days. The mean empirical survival was reduced from 1192 days (no recurrence, (NR)) to 1105 days in the case of a local recurrence (LR); an additional lymph node metastasis (LN) caused a decrease to 607 days. The 5 year survival (Kaplan-Meier estimate) was changed from 62% to 35% (LR) and 0% (LN), respectively. The mean decrease of the Karnofsky Index during follow-up was 0.6 (NR) but was 1.2 for LR and 1.6 for LN. The 2 year survival after a local recurrence was 25%; after an additional lymph node metastasis, 10%. Survival of patients is mostly influenced by the occurrence of lymph node metastases in follow-up. A second prognostic factor is local recurrence. The Karnofsky status is influenced by the local tumour control too.

10.05 – 10.09 am

Concurrent bleomycin and radiotherapy in oral cancer: influence of serum iron on mucositis and tumour control [Poster]

V N Bhattathiri, T T Sreelekha, P Remani,
V Padmanabhan, T Vijayakumar and M Krishnan Nair
Departments of Radiation Oncology, Cancer Research and Nuclear Medicine, Regional Cancer Centre, Trivandrum — 695 011, India

Iron is known experimentally to influence the activity of bleomycin (BLM) and that of radiation. A prospective study was conducted in oral cancer patients, to see if serum iron level influenced the response of oral mucosa or of the tumour to concurrent BLM and radiotherapy (RT). 36 patients with locally advanced epidermoid cancers of the oral cavity were included. Serum iron and total iron binding capacity (TIBC) were estimated prior to treatment. The RT dose was 60 Gy in 25 fractions, and the BLM dose was 15 units twice a week for 3 weeks. The acute mucositis was monitored and graded. Those with Grade 4 mucositis had a significantly higher serum iron level than those with only Grade 3 mucositis (61 $\mu g\ dl^{-1}$ *vs* 106 $\mu g\ dl^{-1}$; $p < 0.05$). The percentage iron saturation was also higher ($p < 0.06$). But, paradoxically, at 6 months, those who had tumour control had a lower serum iron value, as compared to those whose cancer recurred (90.7 $\mu g\ dl^{-1}$ *vs* 124.9 $\mu g\ dl^{-1}$; $p < 0.05$). The results indicate that, as far as the normal tissue is concerned, serum iron enhances the activity of BLM and RT, supporting reported experimental findings. The reverse effect on tumour control is possibly related to the presence of higher quantities of altered or normal, Fe-related protective enzymes, or is just a sign of poor prognosis.

9.00 – 10.13 am

Nuclear Medicine I: Paediatric Urinary Tract

Charter Suite

9.00 – 9.25 am
Radioisotopes and paediatric urinary tract infection [Invited Review]
G C Vivian
Department of Clinical Imaging, RCHT (Treliske), Truro TR1 3RT, UK

This review will address the role of radioisotope imaging in children with urinary tract infections (UTI) and propose a protocol for limiting radiation exposure while maintaining a high screening accuracy. Dynamic renography and static DMSA scintigraphy are well established investigations and have largely replaced the IVU in children with UTI. For children who are toilet trained the indirect radionuclide cystogram is the preferred alternative to the MCUG; the direct radionuclide cystogram may be used for screening infants but the MCUG remains the gold standard. We have used a protocol to interval screen over 1000 infants and children in whom there has been a proven UTI with a high sensitivity and, with up to 5 years clinical follow-up, a low re-referred rate for further investigations. Current controversies including imaging during acute UTIs with DMSA and the small smooth kidney will be discussed.

9.25 – 9.29 am
Plug and Play MRA — challenging isotope renography [Poster]
[1]G Roditi, [1]F W Smith, [2]T W Redpath and [3]J Webster
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We have used TONE-enhanced 3D time-of-flight magnetic resonance angiography (TOF MRA) sequences on 30 (to date) at-risk patients attending for renal digital subtraction angiography (DSA) to determine its potential role in the evaluation of renovascular hypertension. The MRA 3D acquisitions were performed with no preparation, minimal supervision and minimum table times (under 15 min), simulating potential "real life" conditions for a screening test. MIP reconstructions were performed and interpreted without knowledge of DSA results. Correlation was later made with both the DSAs and isotope renograms. The majority (90%) of MRAs were of good quality (as assessed by two observers) but several were degraded by motion artefact and/or poor signal. Despite these limitations the MRAs proved more specific than the isotope renograms which had a significant (17%) false positive rate. While 3D TOF MRA does not rival DSA for diagnosis (with problems of overestimation of stenosis, missed accessory renal arteries and a lack of discrimination between high grade stenosis and occlusion), it can, in our view, rival isotope renography as a cost-effective alternative for screening, with higher specificity (90% compared with 83%) and lack of ionizing radiation.

9.29 – 9.33 am
Imaging infection: a personal algorithm for the use of cell labelling [Poster]
J R Buscombe
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Over the past 22 years many scintigraphic agents have been recommended for the localization of infection. Some of these agents are no longer in use and others are not commercially available. Those presently available in the UK include ^{67}Ga citrate, ^{99m}Tc-labelled human immunoglobulin (^{99m}Tc-HIG), ^{99m}Tc-labelled nanocolloid, and leucocytes labelled either with ^{111}In or ^{99m}Tc hexamethylpropyleneamine oxime (^{99m}Tc-HMPAO-leucocytes). Each agent has its own advantages and disadvantages and might be the best suited to a given clinical situation. However, no clear consensus exists to guide the clinician in determining which agent would be best used for a given clinical problem. For example while the ^{99m}Tc-labelled agents may be readily available, imaging beyond the first day may not be optimal, so that indolent infections may be best imaged with agents with a longer physical half-life. The opposite is also true, in

that the very availability of ^{99m}Tc-labelled leucocytes may make these agents ideal for the rapid imaging of patients with acute and life-threatening infection. The role of newer agents such as ^{111}In-labelled polyclonal IgG must be more fully assessed. We made a literature search for those agents in use since 1971, and also performed a clinical audit of 94 studies over 2 years in an acute community hospital, which enabled us to construct a clinical algorithm which will guide the radiologist in selecting a particular agent for a particular clinical task.

9.33 – 9.37 am

Indium-111-labelled leucocyte uptake in inflammatory conditions of the aorta [Poster]

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Inflammatory conditions of the aorta may present with non-specific clinical features, including unexplained fever. ^{111}In-labelled leucocyte imaging may be performed in such patients to look for occult sepsis or to assess the activity of vasculitis. Of approximately 1100 patients to undergo leucocyte scintigraphy for these indications over a 5 year period, three had focal leucocyte uptake in the aorta. The final diagnoses were: (1) peri-aortitis in Wegener's granulomatosis; (2) aortic dissection in giant cell arteritis; and (3) streptococcal aortitis with impending rupture. In all three cases the uptake was initially not thought to be in the aorta, but in bowel, a paravertebral abscess and in the lumbar spine respectively. Further imaging with CT and MRI led to the correct diagnoses. As the aorta is a rare site of focal leucocyte uptake, errors in image interpretation are likely. The rapid diagnosis of inflammatory conditions of the aorta is essential however, as aortic rupture may be imminent; therefore awareness of the aorta as a potential site of uptake is important. Urgent referral for further imaging is imperative in these cases, as a false or delayed diagnosis may lead to avoidable morbidity and mortality.

9.37 – 9.45 am

SPECTPLAN: a quantitative SPECT imaging-based 3D dosimetry methodology for use in radioimmunotherapy treatment planning [Paper]

H Zaidi
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Accurate dose planning and correct estimations of the therapeutic effect will be necessary when radiopharmaceuticals with more targeting to tumour cells are developed. The majority of dose estimates for radionuclides in radioimmunotherapy are obtained with quantitative planar imaging and the MIRA formalism. Availability of the 3D distribution of activity provided by SPECT can, in principle, be used to provide the spatial distribution of dose. Absolute quantitation by SPECT is now feasible and has been shown to be a clinically reliable and useful technique. A methodology incorporated into a computer program called SPECTPLAN has been developed which will allow for the calculation of absorbed doses in tissues with a uniform or non-uniform radioactivity distribution. The SPECT model utilizes data from a SPECT image to determine the volume and activity concentration of the imaged tissues and organs. For a proper quantitation, photon attenuation and contributions from photons scattered in the patient have been corrected both in homogeneous and non-homogeneous regions in the body. The CT data provide a density map needed for accurate attenuation correction as well as accurate and easier organ definition. A calculational approach provides the spatially varying radiation absorbed dose from non-uniform and/or irregular activity distribution. The algorithm convolves the 3D map of cumulated activity distribution with a precalculated radionuclide-specific absorbed dose point kernel. The hardware environment for SPECTPLAN is centred around a PC 486-50 MHz computer system where Super VGA graphics have been used to display the images. Phantom studies and simulations were conducted to verify the ability of SPECTPLAN to evaluate organ and tumour uptake, volumes, and to calculate absorbed doses. The SPECT measured volumes were correlated with the actual volumes with $r = 0.99$. The method is limited primarily by the spatial and contrast resolution of SPECT images but the program can provide heterogeneity information on the distribution of dose in tumours and soft tissues. In summary, a foundation was developed for a dosimetry methodology that could be used to calculate absorbed doses in target and non-target tissues using uniformly and non-uniformly distributed activity. The software presents an integrated imaging/dosimetry environment and offers a viable methodology for performing prospective treatment planning.

9.45 – 9.49 am

Lymphotropic scintigraphy with ^{67}Ga citrate in the malignant lymphomas [Poster]

B F Sinyuta
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The aim of this study is an evaluation of the efficacy of lymphotropic scintigraphy with ^{67}Ga citrate in adults and children with malignant lymphomas. We perform dynamic

scintigraphy in lymphotropic mode during the first hour of the study, after subcutaneous injection of ^{67}Ga citrate in the first inter-toe space. We perform static scintigraphy after 48–72 h. The one hour of dynamic scintigraphy enables identification of lymph flow changes in the projection of retroperitoneal lymph nodes, while static scintigraphy provides visualization of retroperitoneal tumour sites. This two-fold, complementary, information enables a sufficiently accurate diagnosis of retroperitoneal lesions, and is of particular value in cases of false negative results or those difficult to interpret on palpation or ultrasonography. During this study we also showed lesion sites above the diaphragm. According to our results the use of lymphotropic scintigraphy improves the diagnosis of the spread of malignant lymphoma, and the method should be very useful in clinical practice.

9.49 – 9.57 am

Quantification of neck uptake of iodine-131 in scans of patients with residual carcinoma of the thyroid [Paper]

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The completeness of thyroid ablation after surgery or radioiodine treatment in patients with thyroid carcinoma is often determined by visual assessment of neck activity following a ^{131}I scan. The role of quantifying neck activity has been assessed in this study. 24 patients with carcinoma of the thyroid have been studied. A total of 45 whole body scans have been performed, 30 of these 72 h after a diagnostic dose of 300 MBq of ^{131}I and the remainder 96 h after an appropriate therapeutic dose. The neck activity was quantified by comparing a known source of activity in a Perspex neck phantom. Results showed uptake of up to 29%, and all patients with measured activity of more than 1% of the administered dose were treated with a repeat dose of radioiodine. The uptake values of patients undergoing therapy were compared with external measurement using an energy-compensated GM tube. In comparison with visual assessment without quantification, quantitative measurement has been found to be more accurate in all cases in determining the completeness of ablation, thus providing a reliable indication of the need for repeat radioiodine therapy.

9.57 – 10.05 am

Radiological appearances of radiation pneumonitis secondary to selective internal radiation therapy with yttrium-90 microspheres for inoperable hepatocellular carcinoma [Paper]

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The Joint Hepatoma Clinic, Prince of Wales Hospital, Chinese University of Hong Kong, Shatin, Hong Kong

Selective internal radiation therapy (SIR) is the technique of injecting radioactive microspheres into the hepatic artery to provide targeted treatment of inoperable hepatocellular carcinoma (HCC). We describe five cases where patients developed air space densities in the lungs following treatment with yttrium-90 microspheres. Chest X-ray and computed tomography (one patient) showed characteristic abnormalities in the periphery of the lung. Lung biopsy in all cases showed features consistent with radiation pneumonitis. Several of the biopsy specimens contained microspheres. Prior to treatment, all patients were assessed for lung shunting by hepatic arterial injection of technetium-99m labelled macroaggregated albumin, which is similar in size to the yttrium microspheres. The degree of shunting varied from 14.8% to 45.6%. Three patients underwent partial tumour embolization prior to SIR; this reduced shunting to 10%. Unfortunately this did not prevent the subsequent development of pneumonitis. We conclude that radiation pneumonitis is caused by microspheres transmitted to the lungs by arteriovenous shunting in HCCs. The microspheres embolize small peripheral lung arterioles, causing the characteristic distribution of pulmonary abnormality. Patients with lung shunting of over 15% are at risk of radiation pneumonitis even after attempted prophylactic embolization of the tumour.

10.05 – 10.13 am

The investigation of dementia — still a confusing issue? [Paper]

S V Thorogood, J D Hunter, G C Vivian and R W Parrish

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We retrospectively compared single photon emission computed tomography (SPECT), computed tomography (CT) and electroencephalography (EEG) in the investigation of dementia in 50 psychiatric out-patients. We aimed to investigate the correlation in predefined regions of the brain perfusion and anatomical abnormalities. 10 anatomical regions of the brain were defined on a normal CT and a normal SPECT scan. One radiologist assessed each CT and

another each SPECT by scoring for abnormality in these regions. A sliding scale was used. Comparison was then made with the EEG if available. All patients had both SPECT and CT; 50% had EEG. Correlation between CT and SPECT was poor, with agreement on the final diagnosis in only 58% of cases. Localization of diseased areas was similarly disappointing, with close agreement in 66% of areas. The EEG showed little correlation in both final diagnosis and location of abnormal areas, although a quantitative analysis proved impossible. The results suggest that no single test proves reliable in the assessment of dementia, and that investigation should be limited to those patients in whom there are atypical features. Investigation should then be targeted specifically towards excluding a treatable cause, rather than attempting to define a final diagnosis.

10.45 am – 12.06 pm

Musculoskeletal Imaging: The Spine

Ripley Suite

10.45 – 11.10 am
End plate disease [Invited Review]
V N Cassar-Pullicino
Department of Radiology, The Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry SY10 7AG, UK

Each vertebral body is covered along its superior and inferior surfaces (bony end plates) by hyaline cartilage (cartilaginous end plates). Functionally, the end plates on either side of the avascular intervertebral disc provide: (a) growth of the vertebral body; (b) anchorage for the disc; and (c) a biomechanical and metabolic interface between the vertebral body and nucleus pulposus. The delicate balance in the structure–function interdependence at the disco–vertebral junction is often upset by a host of local and systemic conditions providing a spectrum of end plate disorders. The imaging of these morphological abnormalities is essential in providing an understanding of the underlying pathophysiological processes and their relationship to clinical symptoms.

11.10 – 11.14 am
Current protocols for routine lumbar spine MRI in the UK [Poster]
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MRI installations in the UK have trebled since 1990. 35% of our annual MRI caseload is for suspected lumbar disc prolapse (PID). How is routine lumbar spine MRI currently performed in the UK? 65 UK fixed-site MRI installations were sent a questionnaire relating to MRI of suspected lumbar PID. Questions were asked on numbers of patients, sequences used and scanning parameters, including slice thickness, field of view (FOV) and matrix size, flow compensation and phase wrap. Protocols for patients after lumbar surgery were also requested. 48 replies were received (74%). Two of nine manufacturers represented 69% of installations. Field strength was < 0.6 T in 60%. Information on workload was supplied by 77% of sites, representing 103 900 scans annually, of which 29 400 (28%) were for suspected lumbar PID. Most centres used a combination of spin and gradient echo sequences in sagittal and axial planes: some sequences were machine-specific. Fast spin echo or gradient echo sequences were popular for sagittal imaging (60%). 32% used a quadrature coil. Axial FOV varied widely (18–30 cm). 90% routinely used Gd-DTPA in post-operative cases. This study provides a "snapshot" of routine lumbar spine MRI in the UK. Overall, different centres use broadly similar protocols.

11.14 – 11.18 am
Gadolinium enhancement in MRI of symptomatic nerve roots causing sciatica [Poster]
P N M Tyrrell, V N Cassar-Pullicino and I W McCall
Department of Diagnostic Imaging, The Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry SY10 7AG, UK

Intravenous gadolinium is seldom required in MRI of the lumbar spine. In five patients with large intraspinal lesions it was injected to aid diagnosis. The imaging features were correlated with the clinical signs and surgical findings. Nerve root enhancement at the level of compression, extending proximally sometimes to the conus medullaris, was seen in four cases of sequestrated disc prolapses and one case of an extradural metastasis, which were proven surgically. The underlying mechanism for gadolinium enhancement is probably secondary to blood–nerve barrier dysfunction with endoneural oedema. Visualization of symptomatic nerve roots: (1) may aid pre-operative accurate diagnosis and surgical planning; (2) may indicate a residual/recurrent problem post-operatively; (3) should not be misinterpreted as tumour extension when sciatica is caused by neurogenic tumours.

11.18 – 11.26 am

The thoracolumbar spine on MRI in patients with long-standing ankylosing spondylitis [Paper]

[1]P N M Tyrrell, [1]A M Davies and [2]R W Jubb
[1]The MRI Centre, The Royal Orthopaedic Hospital and [2]Department of Rheumatology, Selly Oak Hospital, Birmingham, UK

The aim of the study is to try and establish the prevalence of cauda equina syndrome in patients with chronic ankylosing spondylitis and to see if MR scanning can detect its development before symptoms commence. Patients with long-standing ankylosing spondylitis have been invited to attend for a MRI scan of the spine. 30 patients have been scanned to date. Findings include: cauda equina syndrome (one case), asymptomatic pseudo-arthrosis (three), increased signal intensity on T_1W images in one or more thoracic and lumbar discs (nine), partial bony fusion (five) and a spectrum of facet joint changes. The study is as yet too small to comment accurately on the prevalence of cauda equina syndrome on MRI, but we anticipated it will be rare. The high signal intensity on T_1W images within the discs is likely to be due to calcium deposition. This is contrary to the usual teaching, but has been described in both the brain and recently in lumbar discs. It would appear that the T_1 shortening is directly related to the surface area of the calcium crystal. MRI can present its own problems in the kyphotic fused spine and this aspect is also addressed.

11.26 – 11.30 am

MR assessment of the spinal complications of ankylosing spondylitis [Poster]

[1]J S Dawson, [1]K J Fairbairn, [2]J K Webb, [3]K Lloyd Jones and [1]B J Preston
Departments of [1]Radiology, [2]Orthopaedic Surgery and [3]Rheumatology, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH, UK

Ankylosing spondylitis is a chronic inflammatory disorder of unknown cause which principally affects the axial skeleton. The precise role of MR in the assessment of ankylosing spondylitis has not been defined. We describe the MR findings in patients presenting with the spinal complications of ankylosing spondylitis. In a 2-year study period (1991–1993) there were 12 patients (9M, 3F) with a mean age of 47.9 years (range 27–63 years). Most patients had long-standing and advanced disease. Sagittal and axial MR images of the spine were obtained with T_1 and T_2 weighting. The spinal complications of ankylosing spondylitis had either a traumatic or a non-traumatic aetiology. Traumatic complications included fracture, extradural haematoma, cord contusion, post-traumatic syrinx and pseudoarthrosis. Non-traumatic complications featured ligamentous and discal ossification, deformity, disco-vertebral inflammatory lesions, atlanto-axial subluxation, cauda equina syndrome and accelerated disc degeneration/osteoarthritic change adjacent to fused spinal segments. Recognition of the spinal complications associated with ankylosing spondylitis is important. MR appears to be uniquely suited to this task and can evaluate all the relevant anatomical structures (vertebrae, spinal ligaments, intervertebral discs, vertebral joints, thecal sac, extradural space and spinal cord) non-invasively.

11.30 – 11.38 am

Spectrum of MRI appearances in tuberculous spondylitis [Paper]

A J Crisp, J S Dawson, J K Webb and B J Preston
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A retrospective analysis was performed to assess the effectiveness of spinal MRI in demonstrating the features of tuberculous spondylitis (Pott's disease). In a 2-year study period (1991–1993) there were 13 patients (7F, 6M) with a mean age of 38.6 years (range 21–69 years), most of them originating from the Indian subcontinent. Sagittal, axial and coronal MR images of the spine were obtained with T_1 and T_2 weighting. Imaging after intravenous Gd-DTPA was not routinely employed. The sites of disease were: cervical (four), upper thoracic (two), lower thoracic (six) and lumbar (one). Affected vertebrae were demonstrated on MRI regardless of whether they were lytic or sclerotic on plain radiographs. Between one and four vertebrae were affected in each patient and vertebral involvement was usually contiguous. Intervening disc spaces were sometimes involved. As well as showing levels of involvement, MRI also identified subligamentous spread, paraspinal extension and the precise mechanism of any cord compression. Other features of tuberculous spondylitis, including deformity, vertebral collapse (to the extent of vertebral plana), posterior element disease, atlanto-axial subluxation and disc sequestration, were also well depicted on MRI. However, tuberculous calcification was difficult to appreciate on MR images. Tuberculous spondylitis could mimic neoplasm by virtue of multiple vertebral involvement, sparing of intervertebral discs and large paraspinal soft tissue masses. MRI provided accurate pre-treatment evaluation of tuberculous spondylitis and was also found to be useful for post-therapy follow-up.

11.38 – 11.46 am

The relationship between surface and radiological deformity in adolescent idiopathic scoliosis [Paper]

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Three-dimensional surface deformity of the trunk in adolescent idiopathic scoliosis (AIS) is affected by changes in patient position. Initial quantification of the curve and its associated deformity, as well as subsequent monitoring, rely on both radiological and surface measurements. However, there is often a discrepancy between apparent radiological and surface deformity. An earlier study demonstrated that the maximum level of vertebral rotation was generally above the apex of the curve. Furthermore, the surface deformity did not correlate well with the underlying radiographic spinal rotations and curvatures. The present investigation studied the dynamics of the 3D deformity associated with changes in patient position on 27 patients with AIS. The trunk deformity was quantified in three positions by measuring the angle of thoracic inclination (ATI) at each vertebral level using a scoliometer. The patients all had full spine radiography in the anteroposterior (AP) erect position. Vertebral rotation and lateral spinal curvature were measured from the radiographs. Body position altered the magnitude of the surface deformity over the whole trunk, with the prone position offering the optimum relationship between 3D trunk shape and radiological deformity. This could be attributed to the ease and standardization of positioning for prone measurements, together with increased patient comfort. It is suggested that adoption of standardized positioning and measurement of surface and radiological deformity will permit consistency of clinical judgement based on these parameters.

11.46 – 11.54 am

Magnetic resonance imaging using single weighting in cervical radiculopathy [Paper]

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Protocols in imaging the cervical spine have usually included T_1 and T_2 sagittal and axial T_2* or 3D acquisition. We prospectively examined a hypothesis that T_2 weighted imaging is of good enough quality to diagnose cervical radiculopathy and that T_1 weighted sagittal images do not provide useful additional information. 30 consecutive patients presenting for MRI with a history of cervical radiculopathy with or without myelopathy were prospectively assessed. Those with intrinsic primary cord disease or who were post-operative were excluded. Two neuroradiologists, blinded to the clinical information, separately viewed the T_2 weighted images alone, and at a later time, the full set of T_1 and T_2 weighted images. Image quality, location and severity of disease, and confidence of diagnosis at each level were scored on 4- or 5-point scales. No significant difference in quality between the T_1 and T_2 weighted sagittal images was found. The T_1 images detected more small discs and showed larger discs more clearly, but with neither observer was a significant difference found in confidence of diagnosis between the two sets (T_2 *vs* T_1 and T_2). We conclude that the T_1 sequence may be safely omitted in this group of patients with a small saving in time and cost.

11.54 am – 12.02 pm

The relative value of T_1 weighted and T_2 weighted axial images in the MRI assessment of degenerative disc disease in the lumbar spine [Paper]

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The advent of fast spin echo imaging combined with the facility to acquire simultaneous axial images at multiple levels has resulted in the ability to rapidly obtain high quality axial T_1 and T_2 weighted images of the spine. The purpose of this study was to assess the relative value of T_1 and T_2 weighted axial images in the assessment of patients with degenerative disc disease in order to establish whether these two sequences provided identical or complementary information. Imaging was performed using an IGE Signa Advantage (1.5 Tesla). T_1 weighted spin echo and T_2 weighted fast spin echo sequences were performed in the sagittal plane and axial plane through selected intervertebral discs. A blinded retrospective assessment of the degree of disc prolapse and nerve root compression was made by two radiologists. T_1 and T_2 weighted axial images were compared separately to the full sequence (T_1 and T_2 weighted axial and sagittal images) which was taken as the standard of reference. 140 discs were examined in 51 patients (age range 22–81 years). The ways in which the information obtained was complementary in some cases and confirmatory in others are discussed.

12.02 – 12.06 pm

Computed tomography in assessment of pedicular screw fixation [Poster]

[1]J F Leahy, [1]V N Cassar-Pullicino, [2]R Haidar, [2]B Mobini, [1]I W McCall and [2]S M Eisenstein

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The purpose of this paper is to assess the role of computed tomography (CT) in confirming or excluding pedicular fixation as a cause of patients' post-operative symptoms. A prospective study was done in 30 patients following Oswestry pedicular screw fixation. CT sections along the axes of the screws were obtained by gantry angulation. The position of the screw relative to the pedicles and neural structures was noted. The angle between each screw and the median sagittal plane was measured. Results were correlated with the plain films. 122 of 166 screws (73%) were centrally situated within the pedicle; 23 (14%) were placed medially, tending to enter the lateral recess of the spinal canal. CT provided a more accurate demonstration of screw position, but artefact and partial volume effects resulted in ambiguity in determining the position of the screw in more subtle cases. Significant correlation between the screw angles and position was not found. In order to obviate these disadvantages, altered CT techniques were devised which enhanced the information provided. We conclude that CT is an adequate method of imaging the position of pedicular screws, particularly if the scanning technique is adjusted to reduce artefact.

10.45 am – 12.18 pm

Clinical Magnetic Resonance

Harewood Suite I

10.45 – 11.10 am
MRI — expensive technology? [Invited Review]
P J Sharpe
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The huge capital outlay coupled with high revenue costs have been a limiting factor in the number of MRI installations in the UK. There is, however, little disagreement about the diagnostic value of MR, particularly in the central nervous and musculoskeletal systems. MR has also been shown to be cost effective in providing the diagnosis in particular disease states. In order to increase the cost-effectiveness of MR, the unit cost per MR examination should be minimized. Factors such as extension of the working day, selective scheduling of patients and the use of preset protocols and "fast" scanning techniques should be considered. Based on experiences at the Somerset MRI Centre this presentation examines both the capital and revenue costs attributable to MR and discusses methods of identifying and reducing the unit cost of an MR examination.

11.10 – 11.18 am
Conspicuity of white-matter lesions using turbo-fluid attenuated inversion recovery (TurboFLAIR) pulse sequences as compared with Turbo T_2-weighted sequences [Paper]
P C Wou, P R Goddard, D J Pressdee and D Prince
MRI Unit, Diagnostic Imaging, Bristol Royal Infirmary, Bristol BS2 8HW, UK

The FLAIR sequence [1] has been described as improving the conspicuity of most brain and spinal cord lesions. The sensitivity of the basic T_2-weighted SE sequence can be increased by lengthening the TR but with worsening artefacts. A preceding inversion pulse reduces artefact by nulling CSF signal. All studies were performed on a Siemens 1 T system using a Power Package TurboFLAIR sequence, based on a RARE technique with an echotrain of 15 (TR 6000 ms, TE 150 ms, TI 1900 ms). Seven slices are acquired in 102 s by TurboFLAIR compared with 281 s for standard FLAIR. The images were compared with those obtained by Turbo SE T_2-weighted sequences (T_2W), assessing the number, extent and conspicuity of high signal areas (HSAs). Of 46 patients studied, eight had normal scans, 14 showed more HSAs on TurboFLAIR than on T_2W, 19 showed more on T_2W and in five an equal number were seen. The areas visible on both TurboFLAIR and T_2W were more conspicuous and more extensive on TurboFLAIR. Juxtaventricular and sulcal HSAs were easily demonstrated on TurboFLAIR. The HSAs seen on T_2W alone were small and likely to represent perivascular CSF spaces.

Reference

1. HAJNAL, J V ET AL, High signal regions in normal white matter shown by heavily T_2-weighted CSF nulled IR sequences. *JCAT, 16,* 506–513 (1992).

11.18 – 11.26 am
Endocrine pancreatic tumours: the role for magnetic resonance imaging [Paper]
N R Moore, C Rogers and B J Britton
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We review our experience using MRI at 1.5 Tesla in the detection of endocrine pancreatic tumours. Eight patients were studied (4M, 4F, age 32–67 years), seven of whom had symptoms of endocrine hyperfunction. MRI studies comprised T_1-weighted spin echo with fat suppression (n = 7), T_1 gradient echo with fat suppression (n = 6) and T_2-weighted images (n = 4). T_1 sequences were repeated after GdDTPA enhancement in six patients. Patients were also examined by transabdominal ultrasound, computed tomography and selective angiography. Histological diagnoses were confirmed at laparotomy (n = 7) or percutaneous biopsy (n = 1). MRI detected 6/8 tumours prospectively (ranging from 5 mm to 2.5 cm). T_1 weighted sequences with fat suppression were most successful at tumour detection. One insulinoma was not detected, but gadolinium was not given and the tumour was visible in retrospect. Ultrasound, CT and angiography each detected only one tumour.

Palpation and intraoperative ultrasound detected all tumours. If pre-operative imaging is required (and for biochemically proven insulinoma this may not be the case) we suggest that if ultrasound is negative, imaging should involve MRI alone.

11.26 – 11.34 am

Oral contrast media enhanced echoplanar MR imaging (EP-MRI) of mesenteric and retroperitoneal masses [Paper]

M M J McNicholas, G W Boland, S Saini, P F Hahn, M J Lee, M A Goldberg and M S Cohen

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Abdominal MR imaging is limited by motion artefacts and lack of suitable gastrointestinal contrast agent. Recent reports indicate that at EP-MRI, motion artefacts are eliminated and aqueous preparations are suitable for bowel marking. We performed a prospective study to evaluate the efficacy of EP-MRI for detection of mesenteric/retroperitoneal masses. 21 patients with 20 mesenteric and five retroperitoneal malignant masses were evaluated. All lesions were identified by CT which served as the 'gold standard'. Conventional T_1W (SE 300/12) and T_2W images (SE 2500/50, 100) were compared with SE T_2W EP-MRI (TR infinite, TE 25, 50, 75) before and after ingestion of 900 ml of Readicat 2. Images were evaluated quantitatively (lesion SNR; bowel to lesion CNR) and by blinded readings. Lesion detection was 78% with EP-MRI after oral contrast, 62% with EP-MRI before oral contrast and 50% with conventional MR. CNR differences between bowel and lesion were significantly higher (mean 28.3) for EP-MRI TE 50 after oral contrast. Bowel SNR ratios (mean 59) were highest with EP-MRI TE 25 after oral contrast. We conclude that EP-MRI enhanced by oral contrast media is superior to conventional MR for detection of mesenteric and retroperitoneal pathology.

11.34 – 11.42 am

External fixation devices: evaluation of safety and image artefact in MRI [Paper]

[2]L K Cannada, [1]P C Wou, [2]J E Herzenberg, [1]E Siegel and [1]P M Hughes

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Metallic external fixators are commonly used in trauma and reconstructive surgery. With the increasing role of MR imaging, it is important to be aware of the hazards posed by these devices. This study aims to determine their safety by quantifying the forces generated in, or adjacent to, the bore of a magnet, and to examine the impact of fixator artefact on image quality. We examined 21 external fixators of both monolateral and cylindrical design. The assembled fixators were suspended in a Perspex box and forces measured at set distances from the isocentre of a Picker 1.5 T magnet. T_1-weighted SE sequences were used to evaluate image artefact in a limb phantom and also in selected cases in a cadaver limb. The images were graded for artefact by two independent observers. Monolateral devices produced a wide range of forces, from negligible to maximal, and variable image artefact, dependent on composition. All halo orthoses produced force within the magnet, and overall, more severely degraded images. This is the most comprehensive review of safety and artefacts in relation to orthopaedic devices. Several fixators would contraindicate MR examination due to their ferromagnetism. We list the forces and artefacts likely to be encountered, relating these to composition, and discuss possible screening methods.

11.42 – 11.46 am

Practical applications of 3D MRI at 0.5 T [Poster]

D Campling, Y Watson, C E Hutchinson and J M Hawnaur

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The main advantages of magnetic resonance imaging (MRI) over other techniques include multiplanar imaging, high soft tissue contrast, good spatial resolution and the use of non-ionizing radiation. Despite these advantages, there are circumstances when conventional 2D multisection sequences are less than ideal. Intrinsic advantages of 3D MRI include improved spatial resolution and signal-to-noise ratio (SNR). In this study, we present our experience of the use of a 3D spoiled gradient recalled echo (SPGR) sequence in craniospinal and body MRI. Techniques and options for 3D imaging in various regions of the body will be discussed and compared with conventional 2D protocols. The advantages and disadvantages of 3D SPGR will be discussed, based on our experience using a 0.5 T Vectra MR scanner. Applications of 3D SPGR which will be described include its use to overcome the restricted coverage obtained using 2D sequences in children, due to consideration of the specific energy absorption rates. In both adults and children, the increased spatial resolution allows small structures such as the cranial nerves and vessels to be identified with greater confidence. 3D SPGR also has advantages in regions of complex anatomy, such as the shoulder and knee joints, and in patients with spinal dysraphism. The ability to reconstruct the data in real time

allows the optimum viewing plane to be chosen after the acquisition, potentially improving patient throughput.

11.46 – 11.54 am

Magnetic resonance imaging of the endometrium prior to embryo transfer [Paper]

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Centre for Magnetic Resonance Investigations, and Academic Department of Obstetrics and Gynaecology, University of Hull, Hull HU6 7RX, UK

Unsuccessful embryo transfer (ET) remains the commonest cause of failed *in vitro* fertilization (IVF) treatment. Controversy exists as to whether transvaginal ultrasound (TVS) assessment of endometrial thickness and echogenicity can be used to determine the likelihood of successful ET. Magnetic resonance imaging (MRI) provides accurate quantitative data and the relative signal intensity can be calculated, to provide information on tissue characterization. This pilot study aims to investigate the possible role of MRI in the investigation of uterine receptivity. 16 women undergoing stimulated IVF, who had three or more fertilized oocytes, were recruited. MRI was carried out 18 h prior to ET using a 1.5 T system (IGE Signa Advantage) with a pelvic phased array coil. T_2 weighted fast spin echo images were acquired parallel and perpendicular to the long axis of the uterus, using a 256^2 matrix and a 4 mm slice thickness. Images were analysed for thickness, cross-sectional area and total volume using an ISG Allegro Workstation. TVS (ALT Ultramark 4; 5MHz probe) was performed on the day of ET to assess endometrial thickness. There was no significant difference in the maximum AP endometrial thickness between the pregnant and non-pregnant groups, using either MR or TVS, nor between the volumes of the junctional zone or myometrium. The mean ($\pm$SD) total endometrial volume was similar for the six conceptual treatments ($56.8 \pm 29.7\,cm^3$) and the 10 non-conceptual ($40.9 \pm 18.5\,cm^3$), but the mean cross-sectional area of endometrium was significantly greater in the conceptual group ($7.6 \pm 2.0\,cm^2$ *vs* $5.0 \pm 2.0\,cm^2$; $p < 0.02$). The SI of the junctional zone was similar in both groups; that of the endometrium less (but not significantly so) in the pregnant group, while the SI of myometrium was significantly less in the pregnant group (81.3 ± 28.8 *vs* 117.8 ± 28.3; $0.05 > p > 0.02$). Despite the small numbers in this pilot study, an interdependence has been demonstrated between endometrial cross-sectional area, myometrial signal intensity and successful implantation, and it is hoped that in the future MR will provide additional useful information on uterine receptivity, which will aid in the understanding of implantation.

11.54 am – 12.02 pm

MRI for pulmonary nodules? [Paper]

R Uberoi, J Kabala and P R Goddard
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MRI is said to be poor for imaging the chest; in particular, it has no established role in the investigation of pulmonary nodules. We reviewed the films of 12 patients with concurrent CT and MRI examinations of the chest (1–4 weeks between the two examinations). Concurrent plain films were also reviewed in five patients. Two patients had lung carcinoma, five had pulmonary metastases, three had lymphoma, one an infection and one patient had calcified granulomas only. Seven cases had multiple pulmonary nodules, and the other five had solitary nodules. MRI identified as many soft-tissue density nodules as CT in nine cases, and more nodules than CT in two cases, but failed to detect two calcified granulomas in one patient. The chest radiograph was the least sensitive method for the detection of pulmonary nodules. We conclude MRI to be a good technique for detecting soft-tissue density pulmonary nodules but poor for heavily calcified lesions. This latter deficiency limits the ability of MRI to characterize detected pulmonary nodules. Short-tau inversion recovery (STIR) and T_2 weighted spin echo sequences were the most sensitive for detecting lesions.

12.02 – 12.10 pm

Subtraction techniques in Gd-DTPA-enhanced MR imaging of breast disease [Paper]

F Flanagan, J Murray, P Gilligan, J Stack and J Ennis
Department of Radiology, University College of Dublin, Institute of Radiological Sciences, Mater Misericoridae Hospital, 52 Eccles Street, Dublin 7, Ireland

We wished to determine the contribution of the digitally subtracted images in visualizing tissue conspicuity, homogeneity and differentiation in patients who had a breast mass investigated by MRI. All patients were referred from the breast screening unit or diagnostic breast centre (n = 40). Flash 3D images were acquired before and after bolus injection of Gd-DTPA (TR = 0.06 s, TE = 0.013 s, FA = 50°). Digital subtraction using standard software was performed on the selected images. The standard MR images, together with mammograms and subtracted images, were reviewed by three radiologists. The images were scored against a number of diagnostic indices. Digital subtraction MR imaging helps to discriminate benign from malignant disease in all histologically proven cases. In malignant breast disease, tumour outline and invasion of adjacent structures was better appreciated on the subtracted images. Tumour homogeneity was improved with subtraction,

thereby enhancing visualization of the smaller tumours. Benign masses were adequately visualized on the pre- and post-contrast images, with little diagnostic contribution from subtracted technology. However, in benign dysplastic disease small focal areas of enhancement and diffuse enhancement of breast could be better appreciated with digital subtraction. We conclude that digital subtraction is a rapid post-processing technique that increases overall diagnostic accuracy in breast disease.

12.10 – 12.18 pm

Proton MR spectroscopy in AIDS: changes in metabolite relaxation times [Paper]

I D Wilkinson, M Paley, W K Chong, R J S Chinn, J K Shepherd, B E Kendall, M A Hall-Craggs and M J G Harrison

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Abnormal cerebral proton magnetic resonance spectra have been observed in patients with the acquired immunodeficiency syndrome (AIDS). At long echo times (TE = 135 ms) reductions in the relative signal from the N-acetyl (NA) resonance may be due to changes in metabolite concentration, relaxation times or both. This study determines the relaxation times of NA, choline (Cho) and creatine (Cr) within AIDS patients. Proton spectroscopy was performed on a Siemens 1.5 T system with various repetition/echo times (1600/135, 1600/270 and 4000/135 ms) on 21 AIDS patients and eight low-risk controls. An 8 ml spectroscopic voxel was placed in the parieto-occipital white matter. T_1 and T_2 estimates were based on a mono-exponential least-squares fit. On T_2 weighted MR imaging 14/21 patients showed evidence of diffuse white matter abnormalities and/or atrophy. Significant reductions were seen in NA/Cr at TE = 135 ms but not at 270 ms. The only statistically significant difference in metabolite relaxation times was an increase in the T_2 of NA in the group of AIDS patients with abnormal imaging compared to the control group (ANOVA with Scheff F-test at 95% confidence limit). These relaxation time effects should be considered when absolute metabolite concentrations are interpreted from proton spectra.

10.45 – 11.54 am

Cranial Paediatric Imaging

Harewood Suite II

10.45 – 11.10 am
Imaging of cerebral malformations [Invited Review]
O Flodmark
Department of Neuroradiology, Karolinska Hospital, S-171 76 Stockholm, Sweden

The neuroradiological diagnosis of cerebral malformation has generated considerable interest during recent years. Increased access to magnetic resonance imaging (MRI) has allowed many more patients, particularly children with non-progressive neurological symptoms, to be investigated on wider indications. Many have been found to have congenital cerebral malformations, thus presenting new challenges for the radiologist's ability in correctly diagnosing these conditions. Although MRI is the method of choice in most instances, many major malformations can be diagnosed with computed tomography (CT). More subtle or focal malformations may require extensive investigations and even high quality MRI can be difficult to interpret correctly. The most likely level of cerebral development at the time of the injury can be estimated by applying knowledge from embryology and teratology. Hence, meticulous diagnosis of the correct type of a malformation becomes important and can have medico-legal implications. Cerebral malformations should be suspected with abnormal head circumference, psycho-motor delay, cerebral palsy and epilepsy. Ignorance of this diagnosis is the most common mistake and the investigation is read as normal or showing atrophy. Successful diagnosis of cerebral malformations depends on excellent radiological technique. Neurosonography is not well suited for this challenge and should not be used when cerebral malformation represents a realistic diagnostic alternative. Correct timing of the investigation and excellent CT, or MR technique with the use of specific pulse-sequences, are necessary for the diagnosis, particularly when ruling out a malformation becomes an issue.

11.10 – 11.14 am
Cranial CT appearances in physical child abuse (non-accidental injury) — diagnostic features [Poster]
J M Tibballs, J C Davis and J Young
Department of Radiology, Whittington Hospital, London N19 5NF, UK

Head injuries are the commonest cause of death as a result of physical abuse. Intracranial abnormalities may be due to direct trauma to the skull, indirect trauma during violent shaking, or hypoxia due to restriction of respiration or cerebral blood flow. As these mechanisms of injury imply, skull fractures are not necessarily present. Consequently cranial CT plays a central role in assessing the presence and extent of acute intracranial injury and its sequelae. An average of 25 cases of physical child abuse are referred to our department for radiological investigation annually. We have reviewed those cases with known or suspected head injury referred for cranial CT scan. We present the appearances that characterize physical abuse and demonstrate the importance of follow-up scans in determining the ultimate extent of intracranial injury. A knowledge of the patterns of CT abnormality due to physical abuse permits confirmation of suspected cases and the alerting of clinicians to the possibility of abuse in unsuspected cases.

11.14 – 11.22 am
MR assessment of age-related development of the sphenoid sinus [Paper]
D Szolar, K Preidler, G Ranner, H Braun, C Kugler, H Stammberger and F Ebner
Department of Radiology, Karl Franzens University Hospital, 8036 Graz, Austria

We aimed to obtain baseline standards of normal age-related development of the sphenoid sinus during childhood. MR images (T_1 weighted sagittal and coronal scans, T_2 weighted axial scans) of the sphenoid sinus in 401 patients less than 15 years old who fulfilled our inclusion

criteria were reviewed (subdividing the patient age groups into 3-month intervals) to establish normal standards. Assessment of the sphenoid sinus entailed analysis of signal intensity characteristics (Grade 1–3) on T_1 weighted images according to age, three-dimensional measurements of the pneumatized sphenoid sinus and evaluation of a septum according to pneumatization. The sphenoid sinus had a uniformly low signal intensity (red bone marrow, Grade 1) on T_1 weighted images in all children less than 4 months old. Signal intensity changes from hypo- to hyperintense (bone marrow conversion, Grade 2) started at age 4 months. Onset of pneumatization (Grade 3) was observed in 12% at age 13–15 months. By age 46–48 months, 85% of the patients showed pneumatization of the anterior part of the sphenoid bone. Pneumatization was complete in all patients older than 10 years. Enlargement of the sinus showed a characteristic profile in each dimension. Median septation was observed irregularly with age, with a maximum of 77%. Septum variants were noticed between 4.5% and 20%. Development (bone marrow conversion, pneumatization) of the sphenoid sinus is more rapid than previously assumed. Absent bone marrow conversion in a child older than 2 years and absent pneumatization in a child older than 9 years should be considered abnormal and should stimulate further clinical investigations. Because paediatric sinus disease is a challenging problem in children, our findings, which could be a useful anatomical landmark in endoscopic sinus surgery to provide preoperative information, may serve as a reference for evaluating normal and abnormal development of the sphenoid sinus.

11.22 – 11.26 am

The Yorkshire craniosynostosis cluster: clinical features and radiological investigation. A pictorial essay [Poster]

[1]K S Naik, [1]C M Craven, [1]K S Blanshard, [1]J A Spencer and [2]A G G Batchelor

[1]CT Unit, Department of Radiology and [2]Department of Plastic Surgery, St James's University Hospital, Leeds LS9 7TF, UK

The recent cluster of cases of craniosynostosis in the York and Selby areas of Yorkshire has afforded a rare opportunity to study the clinico-radiological features of this condition. Here we illustrate both the manifestations of the primary craniosynostoses and the associated syndromes. A series of 20 consecutive infants and children referred for consideration of reconstructive surgery were assessed radiologically with plain radiographs, cranial computed tomography (CT) and spiral CT 3D reconstructions. Unusual among this group was a high incidence of lambdoid synostosis. For each vault suture the abnormalities consequent on premature closure are illustrated by clinical photography, plain radiography, axial and 3D CT with key point summaries. Important operative findings and technique are emphasized in relation to imaging. CT with 3D reconstruction has assumed a central role in the pre-operative assessment of craniosynostosis. Spiral acquisition of images results in improved image quality and reduced patient dose.

11.26 – 11.34 am

Multispiral 3D CT of craniosynostosis: technique optimization, pitfalls, problems and solutions [Paper]

[1]C M Craven, [1]K S Naik, [1]K S Blanshard, [1]J A Spencer and [2]A G G Batchelor

[1]CT Unit, Department of Radiology and [2]Department of Plastic Surgery, St James's University Hospital, Leeds LS9 7TF, UK

Cranial computed tomography (CT) with 3D reconstruction has assumed a central role in the pre-operative assessment of craniosynostosis. The technique requires acquisition of multiple thin sections, and modifications leading to dose reduction are desirable. Misleading artefacts may arise during image reconstruction. We describe the optimization of technique using multiple spiral data acquisitions (Siemens Somatom Plus S) with low-dose (85 mAs) technique and using an ISG Allegro workstation. Two caudad slices 3 mm thick are obtained, with a further volume of 2 mm or 1 mm slices at the vertex. Image reconstruction of spiral raw data allows overlapping 3 mm sections to be generated without the dose increase that would result from the conventional axial imaging. We illustrate common technical artefacts of 3D CT and explain their cause and solution. Anatomical errors resulting from suboptimal threshold selection are demonstrated. 3D CT is an interactive tool allowing dialogue between imaging departments and reconstructive surgeons. Clinico-radiological management of the recent Yorkshire craniosynostosis cluster has enabled us to refine this technique further and to understand its limitations and problems.

11.34 – 11.38 am

The differential diagnosis of prominent "CSF spaces" on paediatric cranial CT [Poster]

J M Tibballs and J Young

Department of Radiology, Whittington Hospital, London N19 5NF, UK

Prominent 'CSF spaces' are encountered on cranial CT in children presenting with increased head circumference. They pose considerable diagnostic difficulty, particularly in the District General Hospital, where recourse to a specialist neuroradiological opinion may be limited. The difficulty lies in distinguishing benign extracerebral effusion, a self-

limiting condition of uncertain aetiology, from more significant conditions such as chronic subdural collections, communicating hydrocephalus and atrophy, which have management and prognostic implications and may necessitate further investigation. We present a series of six cases in our department in the past 6 months, illustrating the initially apparently similar appearances of these different conditions, and highlight the features that enable them to be differentiated. Establishing the correct diagnosis at the time of the initial CT scan facilitates appropriate local management and avoids unnecessary further investigation and/or specialist referral.

11.38 – 11.42 am
Epidural manifestation of acute myeloblastic and lymphoblastic leukaemia imitating acute epidural haemorrhage [Poster]
W Küker, J Reul and A Thron
Department of Neuroradiology, University Hospital, D 52057 Aachen, Germany

We report two children with atypical intracranial manifestations of acute leukaemia. The first child was referred to hospital because of a head injury with progressive mental deterioration. The emergency lab findings suggested an acute leukaemia of unknown cause. CT examination was performed after contrast medium application. An epidural mass was found. However, this mass was interpreted as an acute epidural haematoma due to haemostasiological disturbances of acute leukaemia. Operation revealed a solid tumorous mass. Histologically acute lymphoblastic leukaemia could be confirmed. The second case suffered from known acute myeloblastic leukaemia. CSF examination was normal and enhanced CT examination was done for routine staging. The epidural mass seen again could be misinterpreted as an epidural haemorrhage. These cases demonstrate the importance of adequate neuroradiological examination. We demonstrate that acute lymphomas can initiate intracranial epidural bleeding, leading to false therapeutic consequences. However, CSF examination is insufficient to exclude intracranial disease in cases of epidural manifestation.

11.42 – 11.50 am
Computed tomography in childhood orbital cellulitis [Paper]
[1]N B Wright, [2]M Hero, [2]S Collur and [1]L Abernethy[1]
Departments of [1]Radiology and [2]Ophthalmology, Royal Liverpool Children's NHS Trust, Alder Hey, Liverpool L12 2AP, UK

Orbital cellulitis secondary to sinus disease may lead to serious ocular or intracranial complications. These events are seen in postseptal disease and therefore the identification and assessment of the extent of orbital cellulitis is crucial. We reviewed 28 children with periorbital and orbital cellulitis. Four patients had clinical features of postseptal inflammation (proptosis and restricted eye movements), and therefore computed tomography (CT) was performed. Sinus disease was present in all four cases. One scan showed preseptal inflammation only and one scan showed postseptal inflammation abscess formation. Two patients had subperiosteal abscess formation, confirmed at operation. One of these two had two CT scans: the initial scan was interpreted as minor postseptal inflammation around the superior rectus muscle, but a scan one week later showed a subperiosteal abscess. This patient only had axial scans performed and we feel the initial scan was interpreted incorrectly because of this. In the other three patients, detailed contiguous 4 mm scans in the axial and coronal planes were obtained. These cases illustrate the value of performing both axial and coronal CT in the assessment and staging of orbital cellulitis in childhood.

11.50 – 11.54 am
Autosomal recessive osteopetrosis with renal tubular acidosis and cerebral calcification [Poster]
J Brismar, W A Cumming, S G Larsson and P McDonald
Department of Radiology, King Faisal Specialist Hospital and Research Centre, Riyadh 11211, Saudi Arabia

We illustrate the spectrum of imaging findings in the syndrome of autosomal recessive osteopetrosis associated with cerebral calcification, renal tubular acidosis and carbonic anhydrase II deficiency, the so-called 'marble brain disease' of Ohlsson. A retrospective review was made of the imaging studies in 20 patients with this syndrome. A characteristic pattern of intracranial calcification evolving during early childhood is present and is associated with variable manifestations of osteopetrosis, generally milder than in other forms of autosomal recessive osteopetrosis. Limited studies of the kidneys by ultrasound and CT showed normal appearances. Autosomal recessive osteopetrosis associated with carbonic anhydrase II deficiency is a syndrome with a characteristic pattern of cerebral calcification involving the basal ganglia and cortex and of development of osteopetrosis in the skeleton.

10.45 – 11.58 am

Brachytherapy & Gynaecological Cancer

Bramham Suite

10.45 – 11.10 am
HDR brachytherapy in the treatment of skin tumours [Invited Review]
[1]C A Joslin and [2]A Flynn
Departments of [1]Radiotherapy and [2]Medical Physics, Cookridge Hospital, Leeds LS16 6QB, UK

Although radium has been largely replaced by caesium-137 for loading surface moulds in the treatment of superficial skin cancer, most treatments are now provided by either superficial X-rays or low energy electrons. However, where the treatment volume includes cartilage and tendons and the superficial tissues are thin and overlie bone a case for using surface mould therapy can be made. The authors have been involved for many years with the use of surface mould therapy using sources of radium-226, gold-198 and caesium-137 placed on individually made shells or wax blocks. The spatial distribution of the radioactive sources and quantities used was determined by the Paterson-Parker rules (Paterson-Parker, 1934; Meredith, 1967). The spatial distribution of the radioactive sources and quantities used was determined by the Paterson-Parker rules. The use of active sources in this way may produce an unacceptable hazard to the staff involved. The amount of radioactive material depends on the size of the treatment area and for large treated areas considerable amounts of activity are needed, with consequent restrictions on the time that can be spent positioning the device on the patient, and on nursing and visiting times. In particular, the technical staff who prepare the mould before application, and dismantle it after use, may be exposed to a significant radiation hazard. The introduction of remote afterloading machines offered a possible solution to these difficulties (Joslin et al 1969; Joslin and Smith, 1970) although the use of these techniques has not been reported by many. The presentation will provide information about the general use of high dose rate remotely controlled afterloading for surface moulds.

11.10 – 11.18 am
High dose rate versus low dose rate brachytherapy in treatment of cervix carcinoma [Paper]
F H Glaser, D Grimm and G Haensgen
Clinic of Radiotherapy, Erfurt, and Clinic of Radiology, Martin-Luther-University, Halle/Saale, Germany

High dose rate afterloading (HDR-AL) brachytherapy has introduced a real renaissance in treatment of cervix cancer. HDR-AL prevents the risk of radiation hazard to the staff, facilitates optimization of dose distribution in combination with external beam irradiation and makes treatment easier for patients and hospital. From 1974 to 1984 more than 4500 women with gynaecological tumours were treated, among them 1583 patients with cervix carcinoma. 928 women were irradiated primarily by intracavitary and 655 women post-operatively by intravaginal HDR afterloading. All patients have had a minimum follow-up of 5 years. The results of relapse-free 5-year survival, stage-related, were compared with our own results for 623 cervix carcinoma treated by low dose rate (LDR) brachytherapy and with the international statistics in the Annual Report, Vol. XX. Results in Stage I were 72.8%, because of a high proportion of secondary diseases and death intercurrently and free of cancer signs. In Stage II the results came to 69.0%, in Stage III to 53.3% and for all curatively treated women, Stages I–III, 65.9%. Frequencies of early and late side-effects and complications decreased significantly in comparison to LDR brachytherapy.

11.18 – 11.22 am
Bauer applicator for brachytherapy of endometrial carcinomas [Poster]
R Schulz-Wendtland, M Bauer and M Säbel
Department of Gynaecological Radiology, University of Erlangen, Universitätsstr. 21/23, 91054 Erlangen, Germany

From April 1990 until April 1993 we used the Bauer applicator for 17 patients with advanced endometrial

cancer for exclusive brachytherapy. The Bauer afterloading applicator was developed to simulate Heyman packing. It is designed to allow the intrauterine application of six probes. For the application the cervix has to be dilated up to Hegar 7. After retraction of the tube the individual probes uncoil as a result of their inbuilt tension, placing themselves next to the uterus wall and the tumour. The applicator is compatible with e.g. the Microselectron system. The individual probes can be loaded as desired. Doses, dose distributions and clinical experience with 17 patients are reported.

11.22 – 11.30 am

Prostaglandin-induced cervical dilatation prior to intracavitary radiotherapy for cervix cancer [Paper]

K J Harrington, H E Lambert, S A Kelly, P S Lai and G D Price

Department of Clinical Oncology, Hammersmith Hospital, Du Cane Road, London W12 0HS, UK

In order to determine whether prostaglandin pessaries induce effective cervical dilatation in post-menopausal women with cervix cancer following external beam radiotherapy to facilitate intracavitary brachytherapy, 16 post-menopausal women (12 multiparous, four nulliparous, mean parity 1.9) were investigated. FIGO stages were Ib (2), IIa (4), IIb (5), IIIa (1), IIIb (3), IVb (1). The cervical os was assessed before pessary insertion and again at intracavitary insertion. The maximum sized Hegar dilator passed without mechanical dilatation was recorded. The os was closed in 100% (16/16) of patients before and open in 75% (12/16) of patients after pessary insertion. Mean cervical dilatation was 4.25 H (5.5 H in those with a clinical response). The 12 responding patients had rapid and uncomplicated procedures without recourse to additional mechanical dilatation. Of the four non-responding patients, subsequent mechanical dilatation failed in two cases; both had undergone previous conization of the cervix. The following mild side-effects occurred: abdominal cramps (43.8%), headache (12.5%) and fever (6.3%). We conclude that prostaglandin pessaries produced effective cervical dilatation in 75% of post-menopausal women undergoing intracavitary brachytherapy after external beam radiotherapy with only mild side effects.

11.30 – 11.38 am

Locoregional intra-arterial chemoperfusion in invasive cervical cancer [Paper]

[1]L Defreyne, [2]K Pletzer, [2]H Bonkoff, [2]C Villena-Heinsen, [3]B Kramann and [3]G Schneider

[1]Department of Interventional Radiology, University Hospital Gent, Gent 9000, Belgium, and Departments of [2]Gynaecology and [3]Diagnostic Radiology, University Hospital Homburg, Homburg 66421, Germany

Systemic chemotherapy is a potential pre-operative adjuvant in invasive cervical cancer. As an alternative to systemic chemotherapy, locoregional intraarterial chemoperfusion is a promising method of reducing systemic side effects and increasing concentration of the pharmaceutical in the target organ. To investigate possible advantages of this method, clinical and histopathological data before and after locoregional intraarterial chemoperfusion were compared. Ten patients with invasive cervical cancer (FIGO IIa/b) were treated twice preoperatively by superselective perfusion of both uterine arteries with 20 mg of cisplatin at days 1 and 2, and this was repeated after 3 weeks. Wertheim-Meig's operation was performed another 3 weeks later. From two patients, complete data from diagnostic biopsies and radiological imaging (CT, MRI, angiography) before, during and after chemotherapy could be sampled and were compared with the histopathological specimens (including special immuno-staining) obtained after surgical treatment. On CT and MRI, a reduction of tumour masses of at least 50% could be demonstrated. In most cases, histological investigations showed only a few small areas of remaining tumour tissue. We conclude that preoperative locoregional intra-arterial chemoperfusion of cervical cancer (FIGO IIa/b) is an effective alternative to systemic chemotherapy, with fewer systemic side-effects and high efficiency in tumour reduction.

11.38 – 11.46 am

Relative unresponsiveness of Krukenberg tumours to chemotherapy [Paper]

P H Lee, V M C Nicolson, D Cunningham and A E Taylor

Departments of Radiology and Medicine, Royal Marsden Hospital, Sutton, Surrey SM2 5PT, UK

A retrospective study was conducted on patients with ovarian metastases from primary gastrointestinal tumours in order to compare the response to chemotherapy of the ovarian metastases with that of disease at other sites. The notes and sequential CT scans of 36 patients with ovarian secondaries from gastric carcinoma, colonic carcinoma or carcinoid tumours were reviewed. The primary tumours and all the metastases were measured before, during and

after chemotherapy. Ovarian metastases were found to be less sensitive to chemotherapy than either the primary tumours or the metastases at other sites. The ovary appears to be a sanctuary site for gastrointestinal metastases. Controversially, the results suggest that prophylactic bilateral oophorectomy may be beneficial in women with primary gastrointestinal malignancy.

11.46 – 11.50 am

Selective uterine arterial infusion of cis-platinum for large cervical carcinoma prior to radiotherapy: a report with 5-year follow-up [Poster]

T Sekiya and M Karikomi

Department of Radiology, Kyoundo Hospital, Tokyo 101, Japan

A large carcinoma of the uterine cervix is often not amenable to radiotherapy, and this is one reason why the overall prognosis is poor. Eight patients with a large (> 5 cm) primary cervical carcinoma who had no previous therapy were selected to evaluate the selective uterine arterial infusion of cis-platinum prior to radiotherapy. Six patients were at Stage IIIb, one at IIb and the remaining one at IVa. Unilateral uterine artery was superselectively catheterized in each course of infusion therapy by the Seldinger technique, and 120 mg m^{-2} of cis-platinum was infused in 2 h by a mechanical pump. Five patients had one course of the infusion therapy and three had two courses. In six of the eight patients, more than 50% reduction of the carcinoma was obtained 3 weeks after the infusion. Radiotherapy was completed in each patient after the infusion. Patients were followed up for over 5 years. Six patients are surviving: five are free of disease (one had para-aortic irradiation), and one has para-aortic lymphadenopathy invaded to the duodenum, treated by surgery and radiotherapy. One died from the carcinoma after 4½ years and one was lost to follow-up. The current technique is effective in reducing the size of a large cervical carcinoma and obtaining a better prognosis.

11.50 – 11.58 am

Prognostic factors of squamous cell carcinoma of the vagina [Paper]

S Dixit, H A Baboo and S Singhal

Department of Radiotherapy, Gujarat Cancer & Research Institute, Asarwa, Ahmedabad 380 016, India

We aimed to evaluate the clinical and therapeutic factors which affect the 2 year disease free survival (DFS) of patients with squamous cell carcinoma of the vagina. 70 cases registered between 1985 and 1989 were analysed. 66 cases were treated with radiotherapy: external radiotherapy (XRT) alone given in 21 cases, the rest treated with a combination of XRT and brachytherapy, either in the form of a central vaginal cylinder (CVC) or CVC plus uterine tandem (12 cases). Four cases were treated by surgery plus radiotherapy. The 2 year DFS was 33%. Stagewise the DFS was as follows: 100% (8/8) Stage I, 70% (7/10) Stage II, 19% (8/42) Stage III and 0% (0/10) Stage IV. Results with XRT alone were poor (0/12). In the early stages (I and II), patients who were treated either with combination radiotherapy or surgery plus radiotherapy showed 85% and 75% survival. In Stage III, results were 0% for XRT alone, and 27% for combination radiotherapy. A significant association between vaginal length involvement and survival was noted: 75% for < one-third, 31% for two-thirds, and 13% for > two-thirds involvement. Grade of tumour and age did not show significant association with survival. Doses more than 60 Gy showed longer and higher disease-free survival. We conclude that advanced stage (III and IV), multiple vagina wall involvement, > 2/3 length involvement, XRT alone, and dose < 60 Gy yield poor results. Grade and age were not related to survival.

10.45 – 11.58 am

Nuclear Medicine II

Charter Suite

10.45 – 11.10 am
Radionuclide imaging of acute gastrointestinal bleeding [Invited Review]
P J Robinson
Department of Radiology, St James's University Hospital, Leeds LS9 7TF, UK

In most patients with upper gastrointestinal (GI) bleeding endoscopy will locate the site and cause of bleeding, and also provide an opportunity for local therapy. The cause of lower GI bleeding is often difficult to attribute, even when pathology is found by colonoscopy or barium enema. Nuclear medicine techniques can be used to identify the site of bleeding in those patients in whom the initial diagnostic procedures are negative or inconclusive. Methods using transient labelling of blood (*e.g.* $^{99}Tc^{m}$-sulphur colloid) produce a high target-to-background ratio in positive cases, give quick results and localize bleeding sites accurately, but depend upon bleeding being active at the time of injection. Techniques using stable blood labelling (*e.g.* $^{99}Tc^{m}$-labelled red blood cells) may be positive even with intermittent bleeding but may take several hours to produce a result and are less precise in localization. In order for these methods to become more widely accepted by physicians and surgeons, and for them to be cost-effective, patients should be carefully selected. The most useful application is in patients with recurrent or prolonged bleeding, those with inconclusive endoscopy or barium studies, and those who are high-risk surgical candidates.

11.10 – 11.18 am
Is more always better? The value of early phase imaging in three-phase bone scintigraphy [Paper]
J J Bhattacharya and N W Garvie
Medical Imaging Department, Royal London Hospital, London E1 1BB, UK

Three-phase bone scintigraphy is widely used in the investigation of bone and joint disease, the major indication remaining suspected osteomyelitis. The question however has been raised as to the value of early phases: "I am far from certain that a logical case can be made for three phase bone scanning . . ." (Fogelman, 1990). We reviewed 285 consecutive scans performed over a 20 month period to assess contribution from the early phases. The most common sites for scanning were: pelvis 39%, ankles 17%, knees 13%, wrists 10%. Common indications were osteomyelitis, trauma, prostheses and chronic pain. Abnormalities were sought in each of the three phases. 178 (62%) of studies were abnormal. In 83 (29%) the static image only was abnormal. In 60 (21%) all three and in 32 (11%) static and blood pool images were abnormal. In no case was the dynamic phase abnormal without a marked blood pool abnormality. Increasing workloads make dynamic scanning expensive in terms of utilization of equipment and manpower resources. Dispensing with the first (vascular) phase would simplify the procedure, removing the close coordination needed between bolus injection and computer without sacrificing useful information.

11.18 – 11.22 am
Normal three-phase bone scintigraphy in a child with a painful hip — does it reliably exclude disease? [Poster]
J J Bhattacharya and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

Hip pain is not uncommon in childhood, and frequently resolves spontaneously. However, avascular necrosis, inflammation or infection, unless diagnosed at an early stage, can lead to chronic and debilitating sequelae. The results of 20 consecutive paediatric patients with hip pain were reviewed. The age range was 2 15 years (mean 8.3 years). Male/female ratio was 2:1. All patients had normal skeletal radiography, and normal three-phase bone scintigraphy. Clinical and radiological follow-up was obtained over an interval of 6 24 months, and the eventual outcome was recorded in each case. The results indicate that a normal three-phase bone scintigram has a high negative predictive accuracy in excluding significant disease in this category of patient.

11.22 – 11.30 am

Leg muscle scintigraphy with $^{99}Tc^{m}$ MIBI and single photon emission tomography (SPECT) in the assessment of suspected compartment syndromes of the calf [Paper]

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Departments of [1]Radiology, [2]Nuclear Medicine and [3]Sport Medicine, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK

We proposed to evaluate the use of methoxy isobutyl isonitrile (MIBI) in the detection of compartment syndromes of the calf. There is no sensitive screening technique and the use of intramuscular pressure studies is invasive. 21 patients (mean age 31 years) with symptoms suggestive of chronic compartment syndrome (CCS) and three patients (mean age 53) with suspected acute compartment syndrome (ACS) were studied using $^{99}Tc^{m}$ MIBI and SPECT. Patients with CCS were studied at rest and peak treadmill exercise whereas only rest studies were performed in those with ACS. Of the 21 patients with suspected CCS, three had exercise-induced ischaemia of the posterior compartment with lack of separation of heads of gastrocnemius. The final diagnosis of popliteal artery entrapment was confirmed at surgery in two and angiographically in the third. Five patients had exercise-induced hypoperfusion of the anterior compartments. Of these, two had raised pressure of the anterior compartments; the other three await further investigation and treatment. Of the three patients with suspected ACS, two showed ischaemic muscles on MIBI, confirmed at surgery. The third had acute on chronic peripheral vascular disease, confirmed by angiography. We conclude that leg muscle perfusion scintigraphy with MIBI and SPECT provides a non-invasive method of diagnosing compartment syndromes of the calf.

11.30 – 11.38 am

Abnormal renal parenchymal uptake on bone scintigraphy: what is its significance and frequency? [Paper]

A Sharma and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

The purpose of this study was to assess the incidence of abnormal renal parenchymal uptake (RPU) in bone scintigraphy and to clarify its significance. RPU was defined as abnormal when the activity associated with the renal parenchyma was equivalent to, or greater than, that in the adjacent lumbar spine. In a review of 640 consecutive bone scans, 48 cases of abnormal RPU were found (7.5%). This is higher than previously reported. Malignancy was present in 38 of the 48 scans, but only four had hypercalcaemia, and not all had received cytotoxic therapy or radiotherapy. Increased uptake was also present with one case of HIV infection, two of gout and one of sickle cell disease. We suggest that the finding of abnormal RPU is more common than hitherto described. Various insults may lead to retention of diphosphonate within the tubular cells. In a few patients who had serial scans, these changes were shown to occur rapidly and to resolve completely, suggesting a tubular cell dysfunction rather than permanent structural damage.

11.38 – 11.46 am

The aetiology and distinguishing features of solitary spinal hot spots on planar bone scans [Paper]

F V Coakley, A R Jones, D B Finlay and I P Belton
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We wished to determine the cause of solitary spinal hot spots on planar bone scans and whether the scintigraphic appearances aid in distinguishing benign from aggressive lesions. 65 bone scans showing a solitary spinal hot spot and with no extraspinal abnormalities were identified. Aetiology was determined in 60, based on clinical assessment, follow-up and radiographic findings. The pattern of isotope uptake in the hot spot was classed as paravertebral (related to the lateral spinal margin), panvertebral (diffuse uptake confined within a vertebra), hemivertebral (confined between the midline and lateral spinal margin) or heterogeneous (all others). The aetiology was benign in 44 patients and aggressive in 16. There was a known malignancy in 33 patients, and in this group, 15 had an aggressive cause. Uptake was paravertebral in 20 (all benign), panvertebral in 14 (nine benign), hemivertebral in 13 (nine benign) and heterogeneous in eight (only one benign). Clearly most (73%) solitary spinal hot spots are benign and even in patients with known malignancy just over half (57%) are benign. A paravertebral pattern of uptake is characteristically benign. A heterogeneous pattern suggests malignancy. Other patterns are unhelpful in distinguishing benign from aggressive lesions.

11.46 – 11.50 am

The role of planar and tomographic skeletal scintigraphy in the assessment of low back pain [Poster]

P Kessar and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

Skeletal scintigraphy is widely used to exclude osseous lesions in chronic low back pain. This paper compares the relative sensitivity and specificity of planar bone imaging with SPECT studies, in a group of 49 consecutive patients referred for this condition over a 3 year interval. Scans of

patients aged between 1 and 58 years (mean age 27 years) from the past 3 years were reviewed. Standard anterior and posterior planar images of the lumbar spine were obtained, followed by SPECT using a GE400 AT tomographic camera, and sagittal, coronal and transaxial reconstructions were performed. 31% of the 49 cases examined were positive. Three out of five possible active pars lesions were shown on planar images, and 6/10 for degenerative disease (relative sensitivity of 66% and 60% respectively). In 14 cases SPECT was clearly positive, with one equivocal case. Significantly, SPECT could localize the lesions in 4/5 possible pars defects and in 8/10 for degenerative disease (relative specificity 80%). There was no correlation between plain lumbar X-rays and scintigraphy for a pars defect but a 43% correlation with degenerative disease. SPECT imaging is superior to planar imaging and to conventional X-rays in its sensitivity and ability to accurately localize the site of the abnormality.

11.50 – 11.54 am
The sternal "tie-sign" revisited [Poster]
A Sharma and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

Manubrio-sternal uptake on a bone scan (the "tie-sign") is reported to be a feature of metabolic bone disease. We believe that it is a common finding and reflects changes within the secondary fibro-cartilaginous joint, rather than a primary bone disorder. In a review of bone scans, uptake at the manubrio-sternal junction was found to occur in 13% of cases. Patients' ages ranged between 29 and 79 years, with equal sex distribution. No patient had central chest or sternal pain. Only two patients had osteomalacia. Although there was a wide range of diagnoses, 20% had carcinoma of the lung and were presumably smokers with a higher incidence of chronic obstructive airways disease. We conclude that the tie-sign is commonly seen on bone scans and is not necessarily indicative of metabolic bone disease. Its presence may reflect degenerative change in the symphysis at the manubrio-sternal junction, due to chronic increased inspiratory effort.

11.54 – 11.58 am
Calvarial uptake on bone scanning: an age related phenomenon? [Poster]
A Sharma and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

The variability of calvarial uptake on bone scans has not previously been investigated. The aim of this study was to assess the incidence of diffusely increased uptake in the skull on routine bone scintigraphy. 640 bone scans, taken over a 2 year interval, were reviewed. Calvarial activity was defined as abnormal when it was noted to be greater than in the cervical spine. Patients' age, sex and diagnosis were recorded. Increased uptake was noted in 86 of the scans (13%). Over 80% of the patients were above the age of 55 years, and the female to male ratio was 7:2. Although carcinoma was the most common underlying problem, uptake was seen in non-maglignant conditions. Only two patients had Paget's disease, and one had renal osteodystrophy. We conclude that the uptake of diphosphonate in the calvarium is more common with increasing age, and in women. With increasing age the skull vault tends to reduce in thickness and overall bone mineral content, particularly in post-menopausal women. Increased calvarial uptake may reflect underlying local metabolic changes, but should not be attributed to generalized metabolic bone disease in the absence of other findings.

12.15 – 1.15 pm

Silvanus Thompson Memorial Lecture

Royal Hall

12.15 – 1.15 pm

Multimodality image fusion: going from research to PACS [Eponymous Lecture]

A Todd-Pokropek
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Medical diagnostic imaging now includes a variety of different methods for acquiring images (imaging modalities) many of which are essentially digital, including CT, MRI, CR, DSA, DF, US and NM. Conventional film based radiology may also be replaced using digital images and displays, which is the aim of the use of Picture Archiving and Communications Systems (PACS). Image fusion concerns the use of methods to compare images obtained at different times, possibly from different modalities, perhaps on different patients. The ability to position such images accurately is termed registration. The ability to provide composite images from such registered images is termed fusion. The aim of producing fused images is to extract additional clinical information such as from combined physiological and anatomical information, and to be able to quantify changes and differences. While image registration and fusion have been available as research tools at a number of specialized sites, it is now becoming feasible to make such facilities available as a routine clinical tool. However, such a process requires digital images to be readily available, and to be able to communicate such images easily between modalities and image workstations (using appropriate communications protocols such as DICOM and Interfile). Such facilities fall naturally under the aegis of PACS development, not for the purpose of producing a digital lightbox, but to provide additional clinical tools resulting from the availability of digital image data. The basic methods of registration are based on the matching of: external markers, internal markers, surfaces, and grey-scale information. Registration must be carried out in 3-D and appropriate 3-D display is required as part of the process. Fused images can be displayed in 2-D or 3-D using various techniques such as dual colour maps, temporal averaging etc. The clinical value of this process may be shown, for example, combining: SPECT data on MRI reference data; MRI and CT images; MEG/EEG on MRI and CT; functional images on anatomical maps; and patient data on reference atlases. The clinical value of such multimodality fused images is potentially enormous, and the implications in terms of changing patterns in looking at (and reporting) images in radiology is also considerable. The facility to perform image fusion moves from research to routine as PACS networks become widely available, and should add considerable value to the use of PACS.

2.15 – 3.53 pm

Digital Imaging

Royal Hall

2.15 – 2.40 pm
3D image visualization and analysis [Invited Review]
M A Smith
Department of Medical Physics and the Centre of Medical Imaging Research, Leeds General Infirmary and the University of Leeds, Leeds, UK

Many radiological techniques acquire 3D data sets from volumes of tissue; these are conventionally viewed as separate 2D tomographic sections. Increasingly the 3D nature of the data and new analysis techniques are presenting new applications and opportunities for 3D visualization and analysis. The current increase is as a result of three factors: (1) better 3D imaging techniques, particularly faster MR 3DFT gradient echo sequences and spiral CT which produce voxels of more uniform dimensions; (2) faster, lower cost computer workstations which can enable sophisticated mathematical algorithms to be implemented in an acceptable time frame for clinical use; and (3) the gradual introduction of digital networks and PACS. In addition to traditional radiological imaging modalities there are new optical imaging techniques, including real time video imaging, which require 3D visualization or analysis for some applications. The techniques of 3D visualization will be reviewed and some potential applications of both visualization and analysis will be presented in the areas of enhanced diagnosis, including the combination of images from different imaging modalities, surgical planning, direction of surgical procedures, functional measurement, quantitative measurement and education and training.

2.40 – 2.48 pm
Quantitative analysis of pulmonary aerosol deposition by single photon emission computed tomography and magnetic resonance imaging [Paper]
P M Halson, E Moore, J S Fleming and J H Conway
Departments of Medical Physics and Medicine, Southampton University Hospitals, Southampton SO9 4XY, UK

A technique has been developed to quantify aerosol deposition in the lungs, in order to investigate how this is affected by different sizes of particle and delivery conditions. Aerosols labelled with $^{99}Tc^{m}$ are delivered in a controlled manner to the subject, after which single photon emission computed tomography (SPECT) is performed with a rotating gamma camera. Magnetic resonance (MR) imaging of the thorax is also performed, in order to define the extent of the lungs to allow spatial analysis of the aerosol distribution, and to generate an "attenuation map" to allow reconstruction of the SPECT images in a manner that accounts for γ-ray attenuation. The MR images are segmented into lung, soft tissue and bone regions, then transformed to match the SPECT image volume by using the relative positions of skin markers. Having reconstructed the SPECT images with attenuation corrections, the density of aerosol deposition at any point within the lung will be proportional to the local voxel value in the SPECT image volume (within the limits of the resolution of SPECT imaging).

2.48 – 2.56 pm
Three-dimensional registration of CT and SPECT brain images [Paper]
W R Crum, I Driver, R F Bury, A H Smith and M A Smith
Centre of Medical Imaging Research (COMIR), University of Leeds/Leeds General Infirmary, Leeds LS1 3EX, UK

The registration of tomographic brain images has potential clinical value. The display of functional information (from single-photon emission computed tomography – SPECT) within an anatomical framework (from CT) is one important application. In the past, reliance has been placed on centre-specific acquisition protocols and the use of fiducial markers. Clinical images can originate at different times and from different hospitals and be of varying quality. We have assembled a series of software tools to facilitate registration of three-dimensional data using common points, line segments and surface elements. A philosophy of registration in the face of adversity has been developed; this philosophy covers retrospective registration of brain images of varying quality obtained under a variety of conditions, sometimes from geographically distinct sites. Our priorities are: (a) to register to a known accuracy "typical" SPECT and CT scans; and (b) to be in a position to attempt registration of scans that have been unusually or poorly acquired. Well-registered images have been produced and

used to generate displays showing both functional and anatomical information. The accuracy and clinical importance of fused images in diagnosis is being evaluated with the aid of clinicians.

2.56 – 3.21 pm

Digital X-ray imaging: present picture and future trends [Invited Review]

A R Cowen
FAXIL, The General Infirmary, Leeds LS1 3EX, UK

The preceding decade has seen the accelerating introduction of a wide range of digital X-ray imaging technologies in clinical service in the UK. Digital subtraction fluorography is now a well accepted technique providing both high resolution vascular images and a variety of operational features which facilitate interventional radiology. Grey-scale digital fluorography systems are now widely used in cardiac studies and GI examinations. More recently we have seen photo-stimulable phosphor computed radiography systems replacing conventional film in classical radiographic applications. Further exciting developments in digital X-ray image acquisition are likely. Solid-state imaging technology is likely to play a prominent role in these advances. Having established a base of digital X-ray image acquisition systems it is natural for diagnostic radiology departments to consider ways to evolve a coherent digital imaging infrastructure which will enhance the clinical service they can provide and increase departmental efficiency. Networked laser printers could provide a useful and practical entry point along this path. Migration towards a comprehensive digital image and clinical data network to satisfy the diagnostic information needs both within the hospital and beyond is becoming an achievable (affordable) goal. The commercial availability of effective digital imaging workstations, of a variety of types and specifications, will make an important contribution to this process. Digital image archival is always an important consideration and a variety of solutions to this problem will emerge. In this presentation we will review the current status of digital X-ray imaging and examine some technologies which may prove relevant to radiology departments by the millenium.

Acknowledgments

Colleagues from the UK Department of Health and the major X-ray electromedical and photographic companies who have assisted me in the preparation of this review.

3.21 – 3.29 pm

Processing and manipulation of pulmonary MRI [Paper]

S C Bolton and A R Moody
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A rapid sequence for imaging the lungs and pulmonary vasculature is described. Its application in normal volunteers and patients with known pulmonary disease is demonstrated, and after image manipulation, comparison is made with CT scans. Pulmonary scans were performed on a Siemens Impact 1.0 T scanner, using a modified TurboFlash sequence. Axial images were obtained during breath-holding. The unfiltered images demonstrated focal parenchymal abnormalities, and the summation of three repeated slices improved the signal-to-noise ratio. The images were then transferred via Ethernet to a Sun Sparcstation IPX running ANALYSE™ image manipulation software. Various techniques were used including filtering, segmentation, overlay of colour onto the grey-scale display to highlight areas of abnormality, and image registration of MR and CT images. Although still undergoing evaluation, this sequence and the data processing have been shown to provide significant information about the lungs, mediastinum and pulmonary vasculature. Tissue characterization has been attempted, combined with quantitative assessment of disease. Since no radiation dose is delivered, this technique would be suitable for weekly or monthly repeat checks to monitor the progress of disease or the efficacy of treatment.

3.29 – 3.37 pm

A new image processing and hardcopy system for computed radiography [Paper]

A G Davies and A R Cowen
Faxil, The General Infirmary at Leeds, Leeds LS1 3EX, UK

The use of Fuji based computed radiography (CR) systems has become more widespread. However, several factors still affect the clinical acceptability of the system, such as the image processing algorithm and the hardcopy presentation. Hardcopies produced by the CR system are limited to one film size, and consist of either both "left" (film-like) and "right" (enhanced) images on a sheet of film, or a single image. An enhancement algorithm has been developed at FAXIL, based upon an algorithm originally designed for

processing DSI image data. It is capable of demonstrating the diagnostic detail contained within both Fuji presentations within a single image. The algorithm is incorporated into a Philips' Easy-VisionRAD workstation which processes image data from the CR, and produces hardcopies. Several hardcopy formats are available, including those designed specifically for a particular examination. For example, it is possible to place two mammogram images "back-to-back" on the same sheet of film. Easy-VisionRAD may be connected to a range of laser imagers; at FAXIL a 3M 969HQ is used. The FAXIL system is compared to the Fuji system installed in the X-ray department and the results from this initial comparison are presented. (We would like to thank the UK Department of Health, Philips Medical Systems (Hamburg), and 3M UK for their support.)

3.37 – 3.45 pm
Electrical bioimpedance imaging: topographic–functional approach to tumour diagnostics [Paper]
[1]Y F Babich, [1]A S Potashko and [2]B F Sinuyta
[1]Ukrainian Academy of Science Dipri and Sonar Research Centres and [2]Ukrainian Research Institute of Oncology and Radiology, Kiev, Ukraine

We used a specially developed technique of non-invasive imaging: electrical impedance relief of biotissue surface. A series of new phenomena has already been recorded in 1991 93, *i.e.* autowaves (initial and induced ones), pulsating and stationary spatiotemporal structures (STS). The aim of this study was to investigate differences between the STS-induced behaviour of normal and cancer biotissue. The skin areas (neck, 20 mm × 40 mm), which included tumour spots underlain by lymphoma knots, have been investigated. We registered sequences of frames from these areas and studied the STS (initial and induced) behaviour in response to extremely low-intensity mm-EMF effect and chemotherapeutic agents in hermetic ampoules which were applied to a distant area connected with the area investigated by reflex ties. About 400 frames have been obtained. Tumour spots reveal themselves as progressively less sensitive — "dead zones" — to any outer effect: it is well known that in cancer cells communication is weaker and weaker as the tumour progresses compared with normal cells. These dead zones become broader and flatter as the tumour progresses. Lymphatic knots reveal themselves as epicentres of these zones. It is well known that tumour cells differ from normal cells by their weaker intercellular contacts and communication. Thus tumour spots appear clearly less sensitive than surrounding biotissue. The characteristics of some STS dynamic features (particularly autowaves) strikingly resemble those of known inter- and intracellular calcium waves. We tentatively propose, therefore, that the STS activity may be a result of 3D cooperative intercellular interaction by means of the second messenger waves at the biotissue level.

3.45 – 3.53 pm
The effect of the fractal transform on radiological images [Paper]
J P Y Lay and R H Sawyer
Department of Radiology, Wythenshawe Hospital, Manchester M23 9LT, UK

The size of digitally stored medical images is one of the major obstacles to widespread adoption of PACS systems. Transmission as well as storage is slowed with a typical chest "film" using 2 MBytes. Image compression is used on all systems to reduce file size but with lossless algorithms the maximum reduction is to 20%. Fractal compression uses the natural redundancy within images and stores the components as resolution-independent mathematical equations. We tested the effect of software and a dedicated processor board from Iterated Solutions (USA) on a wide range of medical images. Images were digitized using commercially available flat bed and hand scanners and a video frame grabber. Maximum original image size was limited by the available software to 500 000 pixels with 8 bits of grey scale. Compression ratios from 1:100 to 1:5 were tested, taking an average of 65 s using a 66 MHz-486 PC. At the highest compression ratios 300 images can be stored on a conventional floppy disk. The images are adequate for teaching purposes. Reconstruction takes 3 s or less for small images. Initial receiver-operating characteristic (ROC) curves suggest that 20:1 ratios preserve sufficient data for initial diagnostic purposes. The effect of using a lossless fractal transform to enhance an image will be displayed. This use may generate spurious artefacts and should not be used in medical diagnosis. There is a major potential use however in improving images for publication. The fractal transform is an asymmetrical compression, taking much more time to compress than to expand. This may allow truly portable receipt of images and allows teaching collections to be stored without a CD-ROM.

2.15 – 5.30 pm

Teach-in: MRI of the Spine

Ripley Suite

Imaging strategies in the diagnosis of intramedullary and intradural neoplastic tumours [Invited Review]

R Sigal
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Magnetic resonance imaging (MRI) represents the sole imaging strategy in the diagnosis and follow-up of primary intramedullary neoplasms (astrocytomas and ependymomas), because it is the only diagnostic modality which allows a direct, multiplanar and non-invasive visualization of the entire spinal cord and its environment. MRI is used to diagnose intramedullary tumour, to guide the surgical work-up, and it allows accurate follow-up. MRI is particularly useful because it allows differentiation between the solid portion of the tumour, which should be removed surgically, and the cystic portions. All the other imaging techniques (plain films, myelography, computed tomography and angiography) are obsolete. Spinal cord metastases are rare and may be difficult to diagnose if not associated with osteo-epidural spread. In leptomeningeal tumours, gadolinium-MRI has proved to be the method of choice in establishing the diagnosis, although false negative examinations may be encountered.

MRI of vertebral metastases: indications and technique [Invited Review]

D Vanel
Department of Radiology, Institut Gustave-Roussy, Villejuif 94805, France

The basic examination used in the detection of metastatic bone disease is bone scintigraphy which is sensitive and non-specific. Standard radiographs are used for painful areas, or for checking abnormalities on scintigraphy. MRI is the most sensitive technique but can only study part of the skeleton. T_1-W spin-echo sequences are especially helpful if the marrow is fatty; if not, out-of-phase gradient-echo sequences showing both magnetic susceptibility and the fat–water ratio and contrast medium should be used. They can reveal destruction of the trabeculae and the disappearance of fatty marrow. T_2-W and STIR sequences will also be discussed. After radiation therapy MRI remains efficient at detecting new metastases when a bone scan is often of limited value. The evaluation of the effectiveness of treatment on metastases remains very difficult in the case of fibrosis. In all questionable cases and if the treatment can be changed, needle biopsy is simple, fast and reliable. In the case of spinal cord compression, MRI should be the only imaging modality.

Other participants:

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2.15 – 3.40 pm

Management & Audit

Harewood Suite I

2.15 – 2.40 pm
Utilization patterns resulting from self-referral in diagnostic imaging [Invited Review]
D C Levin
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The aim of this study was to assess the degree of self-referral for radiographic and ultrasound (US) imaging examinations among non-radiologists in private office practice. We studied procedure codes in common use in the USA, utilizing the database of Pennsylvania Blue Shield (PBS), the largest private healthcare insurance carrier in Pennsylvania (approximately 6.0 million subscribers during 1991). 947,000 claims filed from physician private office practices in 65 high volume radiographic and 29 high volume US codes were reviewed. Physicians providing these services were characterized as either radiologists or non-radiologists and utilization by the two groups was compared. Approximately 70% of all radiographic examinations performed in private offices were self-referred by non-radiologists, as were 63% of all US examinations. Utilization patterns varied considerably according to anatomic category. The highest proportions of self-referred examinations were found in skeletal radiography, vascular US, and obstetric and pelvic US. Self-referral is widespread in both general radiography and US in private office practices in Pennsylvania. This raises concern about the potential for significant over-utilization of diagnostic imaging.

2.40 – 2.48 pm
Information to patients before ERCP [Paper]
C L Kay, D Campling and D F Martin
Department of Radiology, University Hospital of South Manchester, Manchester M20 8LR, UK

The right to be given a clear explanation of any proposed investigation or treatment is embodied in the Patient's Charter. The value of written information for patients before radiological procedures has seldom been studied. We have analysed the value of an information sheet about ERCP. 62 patients were given a commonly used information sheet on ERCP before the procedure and questioned in detail afterwards. Based on these findings and on a review of the literature on how to improve written educational materials for patients, the content and presentation of the pamphlet were modified. The audit cycle was completed by the detailed questioning of 86 patients randomly assigned to read the original or modified version. Patients found the modified version significantly easier to read and understand. Modifications of presentation, writing style, readability and legibility were invariably found to be helpful. Appropriate written material is valuable in improving doctor–patient communication, enhancing comprehension, increasing compliance and providing informed consent. Information leaflets are often poorly designed and written in language that patients do not understand. It is therefore important that they be produced using accepted techniques of good written communication.

2.48 – 2.56 pm
Who looks at pre-operative chest X-rays? [Paper]
G D Walker, P Williams and J Tawn
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We wished to determine the use made of pre-operative chest radiography (CXR) in patients undergoing elective surgery, and the impact of this examination on subsequent clinical management. Our audit standards were that (i) 100% of pre-operative CXRs should be reviewed prior to operation; and (ii) pre-operative CXR rate should be $< 12\%$ for elective surgery [1]. In the surgical wards in a district general hospital, pre-operative CXRs performed from 12 26 June 1992 were returned to the ward unreported and sealed in a clearly labelled separate envelope within the main X-ray folder. After the patient's discharge from hospital, the X-ray packet was returned to the department and was examined to see whether the sealed envelope of films had been opened. Re-audit was undertaken from 21

June to 2 July 1993. The survey covered 314 patients in 1992 and 740 patients in 1993. Emergency surgical admissions were excluded. The 1992 study results were presented at surgical and radiology audit meetings, and new agreed guidelines for pre-operative CXR were produced. In 1992 the pre-operative CXR rate was 102/314 (32.5%). Over 75% of these envelopes (77/102) were not removed from the sealed packet and so can have served no part in patient management. In 1993 the pre-operative CXR rate had fallen to 52/740 (7.0%), and this activity now only forms a small part of an increased departmental workload. This audit of clinical practice has proved an effective method of reducing routine but unnecessary use of pre-operative CXR for elective surgical patients. The saving in this hospital is almost 5000 examinations/year.

Reference

1. ROYAL COLLEGE OF RADIOLOGISTS, Pre-operative chest radiology, *Lancet, ii,* 83–86 (1979).

2.56 – 3.04 pm

Audit of the value of double reporting of MRI films [Paper]

C J Wakeley, J E Kabala, A M Jones, D Prince and P R Goddard

Department of Clinical Radiology, United Bristol Healthcare NHS Trust, Bristol BS2 8HW, UK

MRI is a relatively new technique involving complex anatomy, signal interpretation and numerous images per patient. There is enormous scope for errors of omission and commission. A prospective trial was set up to assess the benefit of double reporting. 100 consecutive MRI scans on subjects in whom the areas of clinical interest overlapped with those of both reviewers were studied. The reviewers were two consultant radiologists, one with three years' and the other with six years' experience of MRI. Films were reported blind by both reviewers separately. When there was a disagreement, a third reviewer arbitrated and derived a "consensus opinion" in conjunction with both of the original reviewers. Of the 100 films, there was full concordance of opinion in 61/100. Of the remaining 39 cases, 4/39 were considered "minor non-related" differences, 12/39 "minor related" differences and 23/39 "major related" differences, resulting in a significant change in patient management. Examples of all these will be shown. Double reporting has financial implications for radiological time, which are offset by the savings from alterations in patient management, as well as benefits to the patient! The educational value of double reporting must also be highlighted. These data may prove particularly interesting to many hospitals now in the process of acquiring access to MRI.

3.04 – 3.08 pm

A study of out-of-hours interventional radiology [Poster]

J Flinn and I N Gillespie

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The "out-of-hours" vascular and interventional radiology workload was prospectively studied at the Royal Infirmary of Edinburgh. The aim was to assess the distribution of out-of-hours referrals by clinical indication and by the speciality of the referring clinician, and to review the workload in relation to NHD (National Half Day) recommendations. Radiologists were asked to complete a form for each vascular or interventional procedure performed for a period of one year. 74% of procedures involved consultant radiologists. The most frequently performed procedure (52%) was diagnostic angiography. The commonest clinical indication was acute limb ischaemia (39%), and the largest user of our services was the vascular surgical unit (46%). A high proportion (62%) of procedures involved treatment of patients, many of whom might have otherwise required emergency surgery. 18% of procedures in this study involved thrombolysis. It is well recognized that the growth of interventional radiology has implications for staffing and resources. In conclusion, the impact of new developments, which must reduce the workload for other specialities, should have an impact on resource allocations for radiology departments, and NHD allowances for interventional radiological on-call commitments.

3.08 – 3.16 pm

An audit of outcome following angiography in patients with peripheral vascular disease [Paper]

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Diagnostic angiography is often requested by vascular surgeons on patients with symptoms of intermittent claudication to evaluate the arterial system prior to either radiological or surgical intervention. There are, however, few studies available showing what happens to the patients following their diagnostic angiography. We have followed up our diagnostic angiograms over a 9-month period to see what percentages are undergoing conservative treatment, being revascularized surgically or are undergoing angioplasty. The results of 156 patients are presented. 60 patients were managed conservatively following angiography (average age 73 years, range 49–89 years). 47 patients underwent radiological intervention, *i.e.* angioplasty (average age 62 years, range 44–87 years). Surgical intervention was conducted in 41 patients (average age 64 years,

range 29–91 years). The number of angioplasties by segment was: aorta four (stenosis), iliac 19 (6:1 ratio of stenosis *vs* occlusion), femoral 25 (5:1), popliteal four (4:1). Surgical operations included: 12 amputations, 11 femoral-popliteal grafts, four aortic grafts, four aorto-femoral, three femoral endarterectomy, two embolectomy, two femoral-femoral, one axillary bypass, one sympathectomy, one femoral-tibial, one iliac aneurysm, one femoro-perineal and one aorto-profunda bypass. The results show that a significant percentage (60/156) of vascular referrals are managed conservatively. It is possible that this subgroup could be identified clinically before angiography and alternative, less invasive, imaging be performed on these patients. Further studies are in progress.

3.16 – 3.20 pm
Swallowed foreign bodies — a radiation hazard? [Poster]
C Charlesworth, G de Lacey and D Remedios
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It has been suggested (BMJ, 1993) that infants and children who have swallowed foreign bodies should have X-rays from the base of the skull to the anus. This advice, taken literally, will usually represent unjustified radiation exposure. A penetrated PA film of the neck and chest is adequate in most instances (BMJ, 1991). However, when particular foreign bodies have been swallowed, it may be necessary to consider endoscopic removal, and further imaging is mandatory. This is always the case with sharp objects, and a small number of blunt objects also require additional radiography. Six cases are described and illustrated. An abdominal radiograph which includes the gonads represents unnecessary radiation when a swallowed coin is shown by a normal chest film to be safely past the gastro–oesophageal junction. The other cases demonstrate the possible risks from ingestion of coins, dentures, batteries, chicken bones and fish bones, and management protocols for these various foreign bodies are suggested.

3.20 – 3.28 pm
The use of intravenous contrast agents in "high risk" patients [Paper]
R J S Chinn, D Kessel, A Glover, G Withey and K Walmsley
Department of Radiology, The Middlesex Hospital, Mortimer Street, London W1N 8AA, UK

There is no agreement concerning the appropriate management of patients at increased risk of adverse reaction to intravenous contrast agents. In particular the role of corticosteroid prophylaxis is unclear. To develop a protocol for our department we have assessed the prevailing attitudes across the country. A questionnaire was sent to 95 hospitals in England and Wales, including all those listed as having radiology trainees. Topics covered included: the measures taken to identify "high risk" patients; the management strategies for those patients; the use of corticosteroid prophylaxis and the regimen followed. Of the 70% of hospitals which responded, only half had a written departmental policy. Previous reaction, asthma and atopy were cited most often as risk factors. Most routinely used non-ionic contrast agents. 69% used corticosteroid prophylaxis; the regimens varied from 100 mg of hydrocortisone stat to 180 mg of prednisolone over 4 days. Almost 50% would cancel the procedure if a patient was discovered to be at risk at the start of a procedure. Our department has reviewed its policy. Emphasis is placed on screening the patients at booking. We have clearly defined indications for corticosteroid prophylaxis and the dose regimen.

3.28 – 3.36 pm
CT of acute pancreatitis: is administration of intravenous contrast media cost-effective? [Paper]
G W Boland, S Saini, P R Mueller and M J Lee
Department of Radiology, Massachusetts General Hospital, Boston, MA 02114, USA

CT enhanced by intravenous contrast media (IVCM) is recommended for patients with acute pancreatitis. IVCM is considered to be of particular benefit for pancreatitis of Balthazar grades C–E in whom intervention (surgical or radiological) may be required. We performed a prospective study to determine whether the routine use of IVCM influenced patient management. 74 CT scans (5 mm sections) were carried out before and after IVCM for proven acute pancreatitis. Distribution of pancreatitis by Balthazar grades was A = 14, B = 12, C = 12, D = 15, E = 21. Enhanced CT scans were sequestered and the initial management decision was based on non-contrast CT findings. Any discrepancy on enhanced CT was subsequently discussed with the referring physicians. Patients were followed up during hospitalization to determine the outcome. Intervention was required in 24 patients: surgery for necrosis in 15, percutaneous aspiration of collections in six, and drainage of collections in eight; 27 patients were conservatively managed. Subsequent re-evaluation with enhanced CT did not alter management, although it defined additional necrosis in seven patients. We conclude that the routine use of IVCM for acute pancreatitis does not influence management. This may be due to improved diagnostic quality of thin-section unenhanced CT scans and/or a trend toward more conservative management of these patients. These findings should enable costs to be reduced.

3.36 – 3.40 pm

The post-angiocardiography urogram film in children — why it should be abandoned [Poster]

J R D Tuson, K McHugh, N A Archer,
I O Ostman-Smith, D Lindsell and K Postlethwaite
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The long-standing practice of taking a urogram film after angiocardiography in children with congenital heart disease, to screen for coexistent urinary tract abnormalities, is examined in the context of the changing roles of imaging modalities in urinary tract investigation and increasing awareness of detriment associated with ionizing radiation. A retrospective audit of post-angiocardiography urograms was carried out for the 3 years 1990–1993. 189 urograms were performed in 171 children (88 boys, mean age 18.1 months). 24 urograms (12.7%) were inappropriate, where the urinary tract had previously been investigated. Image quality was suboptimal in 54 (28.6%) of examinations, due to gas, faeces or poor opacification, and two lesions remained undetected on suboptimal films. Urinary tract abnormalities were detected *de novo* in 12 patients (7.0%). In only one patient did the detection of an abnormality by urogram influence clinical management. This lesion was detectable at sonography, as were the abnormalities in the other patients. We conclude that post-angiocardiography urograms can be abandoned in favour of sonographic screening of the urinary tract in children with congenital heart disease.

2.15 – 3.48 pm

Gastrointestinal Imaging

Harewood Suite II

2.15 – 2.40 pm

The case for radiographers performing barium enemas [Invited Review]

A H Chapman
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Our aim was to determine if radiographers can be trained to perform double contrast barium enema examinations of comparable quality to those of radiologists and to assess the value of such a service to consultant radiologists. Ambulant inpatients and outpatients were included in the study. Two radiographers were taught to give intravenous injections and attended a barium enema training course. The first 50 unsupervised examinations were compared with matched examinations performed by radiologists. The studies were evaluated blind for completeness of examination, demonstration of all parts of the colon in double contrast, barium coating, colonic distention, number of exposures taken and screening time. This was repeated again at 1 year. At 2 years the ability of the radiographers to detect pathology was evaluated. No difference was found in any of the parameters recorded. Radiologists' assistance was initially required in 25% of cases dropping to 10% at 1 year and 5% at 2 years. At 2 years radiographers could recognize colonic pathology in 80% of cases. We conclude that radiographers can perform examinations of comparable quality to those of radiologists and when established the service requires a low level of consultant supervision. Radiographers can learn to recognize colonic pathology, providing the opportunity for the examination to be tailored to best demonstrate the pathology.

2.40 – 2.48 pm

Ultrafast CT sialography: three-dimensional reconstruction of the salivary duct system in parotid tumours [Paper]

D Szolar, R Kern, H Braun, K W Preidler, J Kainz, R Gröll and R Rienmüller
Department of Radiology, University Hospital Graz, A-8036 Graz, Austria

We carried out pre-operative assessment of intraglandular tumour achitecture, and discuss its role in surgical planning (lateral versus total parotidectomy); we compare the radiological, histopathological and surgical results. In 10 patients with parotid tumours ultrafast computed tomography (Siemens Evolution: 130 kV, 620 mA, 100 ms scan time, 1.5 mm slice thickness) was performed after catheter placement (Portex 3FG sialography catheter) and application of 2–4 ml non-ionic water-soluble contrast medium in the major parotid duct. After 3D reconstruction of the duct system, analysis was performed to study: (a) anatomical relationships (superficial part, deep part of parotid gland); and (b) the duct system: normal duct system, stenosis, prestenotic dilatation, "break off", and signs of infiltration (wall irregularities, duct displacement). CT assessment of the duct system correlated in 8 of 10 patients. In two cases with negative CT findings, histopathology specimens revealed minimal invasion of the duct system. We conclude that, since pre-operative investigation of parotid tumours is essential for surgery (*e.g.* facial nerve protection), 3D reconstructed ultrafast CT sialography is highly accurate in depicting parotid duct system pathologies and therefore enables the surgical management of parotid tumours to be considerably improved. High image quality (no motion artefacts, no contrast media run-off) was obtained by ultrafast scan times.

2.48 – 2.56 pm

The role of ultrasound in screening patients referred for sialography: a possible protocol [Paper]

M E Murray, T M Buckenham and A E A Joseph
Department of Diagnostic Radiology, St George's Hospital, London SW17 0QT, UK

A prospective study was carried out to assess the relative roles of ultrasound and digital sialography in the investigation of patients complaining of intermittent pain or swelling of the salivary glands. 31 sialograms (18 submandibular, 13 parotid) were carried out on 20 female and 11 male patients (mean age 47 years). Sialography was technically successful in 30 patients, in whom the results of ultrasound and digital sialography were compared. Good

correlation was observed in 25 cases. There was one false negative ultrasound (ectatic ducts on sialography), and one possible false positive (calculi on ultrasound, but none on sialography). Ultrasound in the three remaining patients demonstrated: (a) one solid mass (parotid adenoma), (b) one generally enlarged parotid gland and (c) no detectable submandibular gland parenchyma. It is suggested that patients with clinical features of an inflammatory lesion in the salivary glands should therefore be referred initially for ultrasound examination. If this is normal, or reveals a solid mass, sialography will not give additional information. If calculi, duct dilatation, cystic elements or an enlarged gland are demonstrated, digital sialography should be performed to identify lesions of the main duct such as strictures or calculi.

2.56 – 3.04 pm

Role of ultrasound in the diagnosis and treatment of amoebic liver abscess [Paper]

K Shamsi, A De Schepper and F Deckers
Department of Radiology, Antwerp University Hospital, Wilrijkstraat, 10, B-2650 Edegem, Belgium

Our purposes were (1) to determine the incidence of previously described sonographic features of amoebic liver abscesses (ALA); (2) to describe post-treatment morphology; (3) to evaluate the role of ultrasound in the management of ALA. We retrospectively reviewed sonograms of 48 ALAs in 33 patients. For the second part of the study, 26 patients with 34 lesions were followed echographically after institution of therapy. 84% of the ALAs were located in the right lobe and 72% of them were contiguous with the liver capsule. ALAs were round or oval in 94% of the cases without a definite capsule or wall (81%). 62% of the abscesses were inhomogeneous. Serology was positive in 94% of the cases. While 64.7% of the lesions resolved completely, others showed residual abnormalities in the form of hypoechoic lesions (14.7%), mainly hyperechoic lesions (2.9%) and anechoic lesions (17.7%). Three cases examined by CT showed non-specific features like hypodensity on precontrast scan and mural/peripheral enhancement after constract medium injection. Similarly, on MRI, abscesses showed hypointensity on T_1 weighted images and intermediate to high signal intensity on T_2 weighted images with or without hypointense capsule. On contrast-enhanced dynamic FLASH sequence the enhancement pattern was similar to the pattern seen on CT. No additional advantage over echography was noted. We conclude that echography in combination with serology and clinical data is sufficient for the management of ALA, obviating the need of expensive and invasive techniques in the majority of cases.

3.04 – 3.12 pm

Low-reflectivity periportal collar on liver ultrasound [Paper]

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Departments of [1]Radiology and [2]Pathology, Freeman Hospital, Newcastle upon Tyne NE7 7DN, UK

A low attenuation periportal collar is a well recognized finding on CT in association with a wide variety of hepatobiliary diseases, and abnormal periportal signal has been reported on MR, but we are not aware that the equivalent finding on ultrasound has been described. A low-reflectivity periportal collar has been identified in a series of patients with a variety of hepatobiliary conditions and the histology of their liver biopsy specimens has been reviewed. The common histological features were aggregations of inflammatory cells around the portal tracts and dilatation of vessels. This periportal inflammation appears to correlate with the periportal collar on ultrasound. In cross-section this can appear as a "target" lesion, and the compound effects is that of a coarse texture. The periportal collar has been identified in several different hepatobiliary conditions, all of which appear to share this histological feature.

3.12 – 3.20 pm

Hepatic cavernous haemangioma: confidence evaluation in an incidental and an oncologic population [Paper]

K Shamsi, A De Schepper and F Deckers
Department of Radiology, Antwerp University Hospital, Wilrijkstraat 10, B-2650 Edegem, Belgium

We evaluated the degree of confidence of the radiologist in differentiating haemangioma by ultrasound (US), computed tomography (CT), angiography (AR), and magnetic resonance imaging (MRI) in an incidental and an oncologic (high-risk) population. A retrospective study of 92 cases of proven haemangioma is presented. The diagnosis of haemangioma was confirmed by surgery, by fine-needle aspiration biopsy (FNAB) and by long follow-up. Maximum lesions were diagnosed with high confidence by MRI (88–93%) and by angiography (85–91%) in both the incidental and the oncologic group. 44% of the lesions were confidently diagnosed by ultrasound in the incidental group as compared to the 11% of the lesions in the oncologic group. Similarly, lesions were diagnosed with maximum confidence by dynamic contrast bolus CT in 76% of the incidental group as compared to 48% of the oncologic group. Confidence was also evaluated according to the size of the lesions, but due to the low number of lesions of less than 1.5 cm, the difference in the confidence levels was not apparent. We conclude that in the high-risk group, MRI, if available, should be performed directly after US. In the incidental findings group, if the lesion has typical features, 6 monthly US follow-up is sufficient.

3.20 – 3.28 pm

Hepatitis B cirrhosis: the evolution of ultrasound appearance and suggested grading of severity [Paper]

[1]C Metreweli, [2]N Leung and [1]G Hacking

Departments of [1]Radiology and [2]Medicine, Prince of Wales Hospital, Chinese University of Hong Kong, Shatin, Hong Kong

Hepatitis B cirrhosis is common in the East and particularly so in the Chinese. The evolution of the appearances on ultrasound indicates there are three main phases. In the first, early, phase corresponding to the early response to the virus, the liver function tests are abnormal but the ultrasound is non-specific. In the middle, covert, phase the liver function tests are normal, there are no clinical features and the CT is normal in this phase. The presence of cirrhosis would be unsuspected but for pathognomonic ultrasound appearances. In the third, clinical phase, established nodularity is accompanied by signs of shrinkage, portal hypertension, and finally ascites; at this stage the biochemistry again becomes abnormal and the condition is clinically obvious, and abnormal on CT. The three phases are associated with characteristic appearances of a large number of steps of severity. These can be demonstrated by ultrasound. The importance of ultrasound diagnosis of the covert phase is stressed.

3.28 – 3.32 pm

Ultrasound, CT and MRI findings of focal nodular hyperplasia of the liver [Poster]

K Shamsi, A De Schepper and F Deckers

Department of Radiology, Antwerp University Hospital, Wilrijkstraat 10, B-2650 Edegem, Belgium

We investigated the frequency of the described radiological features of focal nodular hyperplasia of the liver (FNH). 24 cases (28 lesions) were retrospectively evaluated on ultrasound (26 tumours), computed tomography (CT) (26 tumours) and magnetic resonance imaging (MRI) (17 tumours). While ultrasonography showed non-specific findings, CT frequently revealed hypodensity on precontrast scan (69%), transient immediate enhancement after bolus injection of contrast (96%), and homogeneity (85%). A scar was noted in 31% of the cases. Only 12% of the tumours exhibited the typical MRI triad of isointensity on T_1 and/or T_2 weighted images, homogeneity, and a scar which is hyperintense on T_2 weighted images. The most common finding was homogeneity (94%). In two of our cases the scar remained hypointense on T_2 weighted images. This finding, a frequent feature of fibrolamellar hepatocellular carcinoma (FLHCC), has rarely been described in FNH. Three cases, examined by contrast-enhanced dynamic FLASH MRI sequence, showed immediate transient enhancement and the lesions were better delinated than in spin-echo sequence. On the basis of our findings we feel that the features of FNH, although fairly constant, are at times indistinguishable from those of other hepatic tumours like hepatic adenoma, small hepatocellular carcinoma, or FLHCC. Therefore all symptomatic and palpable tumours should zealously be pursued for an early treatment procedure, while small lesions detected incidentally must be kept under active surveillance.

3.32 – 3.40 pm

Transendoscopic miniprobe ultrasound of the biliary tract (MEUS) [Paper]

W R Lees, A Mueller and A R W Hatfield

Radiology Department, The Middlesex Hospital, Mortimer Street, London W1N 8AA, UK

Endoscopic ultrasound has been in clinical use for over 10 years and is of proven value in diagnosis and staging of biliary tract disease. There is now a new generation of ultrasonic instruments available. Balloon tipped catheter probes of 1.6 mm, 2.4 mm and 3.4 mm in diameter operating at 7.5, 12 or 20 MHz can be passed with ease via the biopsy channel of a conventional side-viewing duodenoscope directly into the biliary tree. 50 examinations were made in 20 patients with biliary tract disease, with four different probes of different sizes and operating frequencies. Comparison was made between the quality of diagnostic information obtained by this method, by ERCP, by conventional ultrasonography and by helical CT. No difficulties were encountered inserting the probes by MEUS. In nine patients with normal ducts on ERCP, the presence of stones was seen in five. The most effective probe was of 2.4 mm diameter operating at 20 MHz. Catheter probes are simple to use, do not require expensive purpose-built endoscopes and can provide unique additional diagnostic information in patients with biliary tract disease.

3.40 – 3.48 pm

Ultrasound diagnosis of biliary strictures following orthotopic liver transplantation [Paper]

[1]P D Britton, [1]R Dowling, [1]D S Appleton, [1]D J Lomas, [1]P Farman and [2]D Westaby

[1]Department of Radiology, Addenbrooke's Hospital and the University of Cambridge, Hills Road, Cambridge CB2 2QQ, and [2]Department of Gastroenterology, Charing Cross Hospital, London W6 8RF, UK

We wished to establish the usefulness of ultrasound in the diagnosis of biliary strictures following both paediatric and adult liver transplantation. All patients with biliary strictures diagnosed by percutaneous transhepatic cholan-

giography (PTC) or endoscopic retrograde cholangiopancreatography (ERCP) in whom ultrasound had been performed in the preceding month were reviewed. Strictures were classified as anastomotic, multiple intrahepatic stricture (MIS) or miscellaneous. In 26 children there were 14 anastomotic, seven MIS and five miscellaneous strictures. 16 adults had eight anastomotic, four MIS and four miscellaneous strictures. Duct dilatation was identified in 80% of paediatric and 88% of adult patients. The distribution of dilatation was different in each group, with intrahepatic dilatation seen in only 60% of children but 81% of adults. In adults, intrahepatic duct dilatation was more common than main duct dilatation. Ultrasound was unreliable in the diagnosis of MIS, particularly in children (sensitivity 57%). Ultrasound is reasonably sensitive in detecting biliary stricturing following liver transplantation. Duct dilatation is frequently subtle and asymmetric and a normal ultrasound examination does not exclude significant biliary abnormality.

2.15 – 3.43 pm

Modern Clinical Oncology: Carcinoma of the Breast, etc.

Bramham Suite

2.15 – 2.23 pm

A pilot study of ARCON in patients with locally advanced breast cancer [Paper]

K Pigott, M Saunders, S Dische and D Hall
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Tumour cell hypoxia is a recognized cause of resistance to radiotherapy. In the mouse tumour model, using clinically relevant dose-fractionation schedules, the addition of carbogen to overcome chronic hypoxia, and of nicotinamide to prevent acute hypoxia, results in a marked increase in radiosensitivity (ER 1.8 2.1), with a lower degree of sensitization in normal tissue: skin (ER 1.3). Six patients with locally advanced breast cancer were entered into a pilot study of ARCON, to determine whether patients tolerated the addition of carbogen and nicotinamide and to assess any increase in radiosensitivity of the skin. Patients received 30 Gy prescribed to the intersection dose in six fractions over 17/18 days with full skin bolus to the tumour. All patients were given 6 g of nicotinamide orally 90 min before radiation treatment, and carbogen breathing was started 5 min before, and continued throughout, radiation. Treatment was tolerated well, with one patient vomiting on two occasions shortly after radiation treatment, and another patient requiring admission due to a bleeding tumour. No increase in skin reaction was noted with the addition of carbogen and nicotinamide, and good tumour regression was achieved.

2.23 – 2.31 pm

An audit of breast radiation dosimetry using three-dimensional dose distributions [Paper]

A J Neal, M Torr and J R Yarnold
Departments of Physics and Radiotherapy, The Royal Marsden Hospital, Sutton, Surrey SM2 5PT, UK

This study was performed to assess dose inhomogeneity within the irradiated breast. 10 women underwent a planning CT scan and 10 mm contiguous axial images were acquired from at least 2 cm above to 2 cm below the breast. The breast target volume was contoured and a 3D plan was devised using the patient's original 2D plan parameters. Slight changes in the beam parameters were permitted to ensure that the target volume was enclosed by the beam edges with a 6 mm margin as seen with the beam's eye view facility. A 3D dose calculation was performed using an equivalent pathlength inhomogeneity correction, and a target dose volume data calculation performed using a $5 \times 5 \times 5$ mm calculation matrix and dose bins for $< 95\%$, 95 105% and $> 105\%$ of the target absorbed dose. The results indicate degrees of dose inhomogeneity not suspected from the original 2D plans, the volume outside the desired 95 105% range varying from 0.2% to 23.8%. The degree of inhomogeneity was positively correlated with the size of the irradiated breast ($r = 0.91$, 95% CI 0.66–0.98). These results suggest that breast dosimetry using current 2D planning techniques is suboptimal, particularly for women with large breasts.

2.31 – 2.39 pm

Minimizing cardiac irradiation in breast radiotherapy [Paper]

C Coyle, B Magee, G G Ribeiro, N Bowl, B Kane, D Temperley, B M Carrington and M Kirby
Departments of Clinical Oncology, Diagnostic Radiology and Medical Physics, Christie Hospital, Manchester M20 9BX, UK

Given the increasing numbers of patients receiving radiotherapy following breast-conserving surgery, concerns have been expressed about the effects of such radiotherapy on normal tissue function, particularly cardiac function. To assess this problem we reviewed the planning CT scans of patients receiving breast radiotherapy. A tangential pair of fields encompassing the breast was used; a separate parasternal or internal mammary field was not used. The CT scans of 420 consecutive patients treated in 1991–1992 were reviewed. Of these, we identified 51 (12%) where the planned field encompassed the cardiac shadow. Radiological assessment suggested that in these cases a short segment of the left anterior descending coronary artery near the cardiac apex was involved. A separate group of patients, treated using an isocentric technique for tangential breast irradiation which incorporated asymmetric collimation of the beams, were reviewed using the megavoltage images of the treated fields. Of 85 images, the cardiac shadow was irradiated in five (6%) patients. We are

currently reviewing our practice over the last 6 months. With good technique, unnecessary cardiac irradiation can be minimized or eliminated for most patients.

2.39 – 2.43 pm
Dosimetry of large parallel opposed irregular field treatments [Poster]
E M Donovan and G F Brunton
Department of Medical Physics and Bio-engineering, Raigmore Hospital, Inverness IV2 3UJ, UK

The dosimetry and planning of treatments using large parallel opposed irregular fields has been investigated as part of the Quality Assurance Programme in the Radiotherapy Department at Raigmore Hospital. A survey of the UK users of the treatment planning system in use at Inverness showed a high level of dependence on manual calculation methods and that the manufacturer's software for irregular field dosimetry is not in general routine use. The present work has concentrated on investigating approximation methods for irregular field dosimetry suitable for manual calculation and in-house software development. Its aim is to develop an efficient method of point dose calculation suitable for local use. The approximations made in point dose calculation in irregular fields arise from: (a) estimation of equivalent square field sizes appropriate to the points of dose calculation; (b) correction for the off-axis radiation beam profile; and (c) estimation of the appropriate radiation output factor correction, to account for the presence of shielding blocks. Dose predictions incorporating these approximations are being compared with results of measurements made in a water phantom using an ionization chamber and in an Alderson Rando phantom using lithium fluoride dosimetry. The dose predictions are generated by in-house software for three treatment types. The results of the experimental investigations and the recommendations for irregular field calculations are presented.

2.43 – 2.47 pm
Oestrogen receptor (ER) expression in ductal carcinoma *in situ* (DCIS) and its radiological correlations [Poster]
A J Evans, S Pinder, I O Ellis, C W Elston, D N Poller and A R M Wilson
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Oestrogen receptors are of interest in DCIS as expression may predict response to Tamoxifen. The value of Tamoxifen in patients with DCIS is currently being studied by the UKCCCR DCIS multicentre trial. Our present study compares the radiological features of ER-positive and ER-negative DCIS. The mammograms of 100 patients with DCIS were reviewed by a radiologist unaware of the ER status. Differences in the radiological features between the 22 ER-positive and the 78 ER-negative cases were sought. ER positivity was seen in 27% ($n = 10$) of small cell DCIS and 19% ($n = 12$) of large cell DCIS. No difference was seen in the proportions of those with normal mammography, soft tissue abnormalities or microcalcification in the two groups. When compared to ER-negative DCIS, ER-positive DCIS manifested by microcalcification more commonly showed predominantly punctate calcification (seven cases (41%) *vs* five (9%), $p < 0.005$) and, less commonly, rod-shaped calcification (seven cases (41%) *vs* 44 (80%), $p < 0.005$). Although at present these findings are not practically useful, once the role of Tamoxifen in treating DCIS is established they may be helpful.

2.47 – 2.51 pm
Regional breast chemotherapy — a new angiographic method [Poster]
[1]D H A McCarter, [2]J C Doughty, [2]C S McArdle, [2]T G Cooke and [1]A W Reid
Departments of [1]Radiology and [2]Surgery, Royal Infirmary, Glasgow G31 2ER, UK

Fifteen per cent of women with breast cancer present with locally advanced disease. Conventional treatment consists of systemic chemotherapy. Although good responses have been reported, systemic toxicity is high and local recurrence rates of up to 38% occur. Regional chemotherapy delivers higher levels of drug to the tumour, with decreased systemic toxicity. In the breast it is conventionally delivered by surgical implantation of a catheter into the subclavian artery. More selective perfusion is obtained by radiological catheterization of the internal mammary artery (IMA), but unwanted perfusion of the anterior abdominal wall and absent perfusion of the lateral aspect of the breast occur. Coil placement in the distal IMA prevents the unwanted abdominal wall perfusion. We have delivered chemotherapy to the whole breast by selective catheterization of the IMA and the lateral thoracic arteries after prior embolization of the distal IMA. Six patients have been treated with this combined approach. No technical complications were encountered, and systemic toxicity was minimal. Perfusion of the whole breast was achieved in every patient and all tumours were downstaged sufficiently to enable mastectomy to be successfully performed. We conclude that this new method is a safe and effective way of delivering regional chemotherapy to the whole breast.

2.51 – 2.55 pm

Sonography as a means of monitoring response to regional chemotherapy in large inoperable breast tumours [Poster]

[1]B Kelly, [1]J C Doughty, [2]A W Reid and [1]C S McArdle
Departments of [1]Surgery and [2]Radiology, Royal Infirmary, Glasgow G31 2ER, UK

Sonography has an established place in the imaging of patients with breast tumours. In this study 12 patients with large inoperable tumours underwent serial sonographic and clinical evaluation during treatment with four pulses of regional chemotherapy to the breast. Serial clinical estimations were made of tumour size, using callipers placed in two mutually perpendicular planes. Sonograms were performed of the tumour in two mutually perpendicular directions using the Diasonics Spectra machine and a 7.5 MHz curved linear array probe. Multiple measurements of the area were made using tracker ball. The same measurements were made for axillary nodes. Decrease in tumour size was observed clinically and sonographically in all patients. Sonography was more accurate in estimating the response to treatment, final size of the tumour and the presence of axillary nodes. We conclude that sonography is a valuable tool in estimating response to chemotherapy in patients with large inoperable tumours.

2.55 – 2.59 pm

Locally advanced breast carcinoma — a new selective angiographic technique of delivering regional breast chemotherapy [Poster]

[1]D H A McCarter, [2]J C Doughty, [2]C S McArdle, [2]T G Cooke and [1]A W Reid
Departments of [1]Radiology and [2]Surgery, Royal Infirmary, Glasgow G31 2ER, UK

Gaining local control in Stage III breast cancer remains a difficult oncological problem. Regional chemotherapy delivers high doses of drug to the breast with minimal systemic toxicity. The conventional method is operative insertion of a subclavian artery catheter. Angiographic placement of a catheter into the internal mammary artery is a more selective method of delivering chemotherapy, but is complicated by perfusion of the anterior abdominal wall. To eliminate this unwanted perfusion we have employed a new method of internal mammary artery catheterization, plus coil embolization of the distal internal mammary artery. The distribution of chemotherapy was compared before and after coaxial coil embolization of the distal internal mammary artery, in a series of 12 patients with large inoperable breast cancer. The distribution of chemotherapy was identified by injecting patent blue dye and radiolabelled microspheres via the catheter. Unwanted distribution to the anterior abdominal wall was eliminated following coil deployment in all but one patient. Arteriographic catheterization of the internal mammary artery with distal embolization provides a safe and more selective method of delivering regional chemotherapy to the breast.

2.59 – 3.07 pm

Breast carcinoma: mammographic responses to neoadjuvant chemotherapy with pathological correlation [Paper]

S Vinnicombe, D MacVicar, R Guy, J Sloane, G Knee and T Powles
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We planned to document mammographic responses to neoadjuvant chemotherapy in breast cancer and correlate them with pathological responses. 104 patients with cytologically proven breast carcinoma had neoadjuvant chemotherapy followed by surgery. Mammograms before and after four courses of chemotherapy were assessed by two experienced radiologists without knowledge of clinical response. The size, density and border of any mass, and the presence of microcalcifications, were recorded. Responses were graded: CR = complete response, MR = mammographic response (decreased size and/or density of mass), SD = stable disease, PD = progressive disease. 98 complete data sets were assessed. Responses were: CR—7, MR—76, SD 7, PD—2. In six cases the primary tumour was not assessable. The commonest response was decreased size and density of a mass. Microcalcification was present in 42 patients and resolved in none. Only eight patients had no histological evidence of malignancy at the end of treatment. 76 had residual invasive carcinoma and eight had ductal carcinoma *in situ* (DCIS) alone; 49 had some areas of DCIS. Residual tumour was present in four of the seven patients with mammographic CR. In all, 90% of patients show some response to chemotherapy, although complete recovery is rare. However, the degree of pathological response could not be predicted from mammographic changes.

3.07 – 3.15 pm

Refractive CLL treated with lymphocytes labelled with $^{114}In^{m}$ [Paper]

R A Cowan, M Drayson, H Sharma, B Murby, S Owens, P M Nuttall, J Chang, D P Deakin and D Crowther
Department of Clinical Oncology, Christie Hospital NHS Trust, Manchester M20 9BX, UK

We have developed a technique for the targeting of therapeutic radiation to lymphoid tissue using autologous lymphocytes labelled with the beta-emitting radionuclide indium-114m. 10 patients with refractory CLL were treated

with $^{111}In^{m}$-labelled lymphocytes. This was carried out as an out-patient procedure and the administered activity ranged from 65 to 210 MBq. Seven of the 10 patients showed a significant response as defined by at least a partial remission in the palpable adenopathy and organomegaly and a fall in the peripheral lymphocyte count by at least a factor of 10. The duration of response ranged from 2 to 12 months and the survival of responders ranged from 4 to 36 months. The treatment was well tolerated with no subjective toxicity. There was significant myelosuppression: in particular, thrombocytopenia; and three patients required intermittent platelet support. This technique produced a significant tumoricidal effect in patients with advanced disease resistant to conventional therapy, and represents a new concept in the targeting of cytotoxic agents in lymphoid cell malignancy.

3.15 – 3.19 pm

2000 patients entered into the axis colorectal cancer trial [Poster]

AXIS Collaborators: all participating surgeons and radiotherapists

AXIS Steering Group, AXIS Trial Office, 5 Shaftesbury Road, Cambridge CB2 2BW, UK

The UKCCCR Adjuvant X-ray and 5-FU Infusion Study (AXIS) has recently recruited its 2000th patient. The aim of the trial is to determine the role that radiotherapy and intraportal chemotherapy may have in the adjuvant treatment of colorectal cancer. The trial was designed to have simple entry and follow-up criteria, in order to ensure that the large recruitment target of 4000 patients would be reached. Patients with rectal cancer are eligible to be randomly allocated to pre- or post-operative radiotherapy and may in addition be randomized for a one-week intraportal infusion of 5-fluorouracil. Patients with colon tumours are randomized only into the chemotherapy arm. 45% of the patients entered have had rectal cancer, 55% colon cancer. No serious morbidity has been reported in patients receiving pre-operative radiotherapy, while 4% of patients receiving post-operative radiotherapy have experienced some morbidity. In 6% of patients randomized to receive chemotherapy, surgeons have experienced difficulties in inserting the intraportal catheter. The AXIS Data Monitoring Committee, who meet annually to review data on toxicity and long-term outcome, have recently recommended that the trial should continue. Further recruitment into AXIS is required, so that the trial will be able to make a valuable contribution to the debate regarding adjuvant treatment of colorectal cancer.

3.19 – 3.23 pm

Radiological appearances of oat cell carcinoma of the oesophagus [Poster]

J D Hunter, S V Thorogood and M P Williams

Imaging Department, Derriford Hospital, Plymouth PL6 8DH, UK

Extrapulmonary oat cell carcinoma is a rare neoplasm which has been reported in the larynx, trachea, salivary glands, cervix and oesophagus. There are 72 reported cases world-wide of primary oat cell carcinoma of the oesophagus, a large proportion of which are in the Japanese population. We present the radiological findings in three cases of primary oat cell carcinoma of the oesophagus in Caucasian patients. Computed tomography (CT) of the thorax was performed in all three cases. Two of the cases demonstrated extensive bulky oesophageal tumours; in one case the marked concentric thickening of the oesophagus extended from the root of the neck to the cardia, in the other there were similar appearances from the carina to the cardia. In the third case there was a small lobulated tumour in the lower third of the oesophagus. While it is recognized that the CT findings of carcinoma of the oesophagus can include concentric oesophageal wall thickening, this is uncommon in squamous cell carcinoma. Although the literature suggests that the appearances of oat cell carcinoma of the oesophagus are variable, we recommend that the finding of extensive concentric oesophageal wall thickening should lead one to consider the diagnosis of this rare tumour.

3.23 – 3.31 pm

The association between the expression of the Nm23 metastasis suppressor gene and prognosis of 89 patients with sarcoma [Paper]

M Robinson, T Stephenson, J Royds, C Fisher and R Rees

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Decreased Nm23 gene expression is associated with metastasis in breast cancer. This study was designed to determine whether this is the case in soft tissue sarcoma. Immunohistochemistry using antibodies to Nm23 peptides was performed on paraffin sections from 89 patients with soft tissue sarcoma. Each case was graded according to the degree of staining: 0–25% – Grade 1; 25–50% – 2; 50–75% — 3 and 75–100% — 4. Univariate and multivariate analyses were carried out to determine associations between metastasis, recurrence, death and Nm23 staining and other prognostic factors. Nm23 staining: 40 Grade 4, 30 Grade 3,

16 Grade 2 and three Grade 1. No association between tumour type, site, size, grade or patient's sex, age, survival, time to metastasis or local recurrence and the degree of Nm23 staining was seen. Tumour grade was the only significant prognostic factor for survival or metastasis on multivariate analysis. The time to metastasis in those patients with 50–75% tumour staining for Nm23 was longer than for similar patients in other staining groups, but this was not an independent prognostic factor. Soft tissue sarcomas demonstrate variable expression of the Nm23 gene which does not correlate with metastatic potential or other known prognostic factors.

3.31 – 3.35 pm

Association of certain viruses with human oral and cervical cancer [Poster]

T Vijayakumar, K R Shanavas and D M Vasudevan
Department of Science & Technology, Trivandrum, India, PIN-695 037, and Department of Biochemistry, Medical College, Trichur, India

Oral cancer constitutes about 27% and cervical cancer about 14% of the total cancers in Kerala, India. Many aetiological factors such as chewing and smoking of tobacco, alcohol consumption, etc. have contributed to the higher incidence of oral cancer, and early marriage, repeated pregnancies, multiple sexual partners, etc. to cervical cancers. The exact aetiological factors are not yet known. Some studies have shown an association of Epstein-Barr virus with Burkitt's lymphoma and nasopharyngeal carcinoma. The present case-control study was undertaken to see if any of the following viruses were associated with oral and cervical cancers: hepatitis B virus (HBV); herpes simplex virus Type-1 (HSV-1); herpes simplex virus type-2 (HSV-2); human herpes virus Type-6 (HHV-6); human papilloma virus (HPV); and Epstein-Barr virus (EBV). No association could be found between EBV and human oral or cervical cancers. Hepatitis B surface antigen (HBsAg) was detected by reverse passive haemagglutination (RPHA) and counter immuno-electrophoresis in the sera of more than 10% of the patients with carcinoma of the cervix and carcinoma of the oral cavity, whereas only 4% of the control population had a positive test. Anti-HSV-1 and anti-HHV-6 antibodies were detected in a significantly higher titre in oral cancer patients, and anti-HSV-2 antibodies in cervical cancers, by complement fixation, passive haemagglutination and ELISA techniques. The presence of HSV-1 antigens in oral cancer tissues and HSV-2 and HPV antigens in cervical cancers were demonstrated by immunofluoresence and immunoperoxidase techniques. The presence of HSV-1 DNA segments was also demonstrated in oral cancer biopsies by dot blot and *in-situ* hybridization techniques. The role of these viruses in the above cancers are not fully known. They may be playing a role as co-factors or promoters in carcinogenesis.

3.35 – 3.39 pm

Chemotherapy of late hepatic carcinoma by mitomycin microcapsule embolism [Poster]

Q-S Zhang *et al.*
Nanjing Hospital, Chinese People's Armed Police Forces, Nanjing 210024, China

10 cases of late hepatic carcinoma were treated from September 1989 to September 1992 with hepatic artery perfusion and mitomycin microcapsule embolism (eight men and two women, aged 40–58 years, disease course of 1–10 months). Seldinger's incubation was employed, and following the hepatic arteriography we mainly used mitomycin microcapsule chemotherapeutic embolism. Results to date are: complete remission three, partial remission three, no change four; in survival time, one > 3 years, three > 1 year, three > 6 months and the other two > 3 months. The study showed that late hepatic carcinoma can be treated by hepatic artery perfusion and embolism by a mitomycin microcapsule. It is considered as the first therapy for those patients with late hepatic carcinoma who cannot be treated surgically.

3.39 – 3.43 pm

Incidence of avascular necrosis of femoral head shown on MRI following chemotherapy for lymphoma [Poster]

[1]F J Gilbert, [2]M A Ratcliffe, [2]A A Dawson and [2]N B Bennett
Departments of [1]Radiology and [2]Haematology, Aberdeen Royal Hospitals NHS Trust, Aberdeen AB9 2ZB, UK

Avascular necrosis (AVN) is a recognized but rare complication of chemotherapy for lymphoma. Early diagnosis is helpful as it may prevent morbidity. Magnetic resonance imaging (MRI) has been shown to be highly sensitive and specific for this condition and will demonstrate abnormalities prior to plain radiology, CT or even radionuclide bone scans. The incidence of radiological changes in this group of patients has been reported as less than 2%, with a variable incidence of abnormalities on bone scintigraphy. The aim of this study was to ascertain the incidence of AVN in the femoral heads as detected by MRI and attempt to establish the time period in which changes develop. 60 patients were recruited into the study, 20 being followed longitudinally with 6-monthly scans on completion of their treatment. The remainder had one examination as part of a cross-sectional study, a mean of 5 years after therapy. 15% of both groups had evidence of AVN on MRI, with only three patients showing radiological changes. The similar percentage of AVN in both groups suggests that initial changes may well develop during or shortly after treatment.

2.15 – 3.49 pm

Nuclear Medicine III

Charter Suite

2.15 – 2.40 pm
Cudgel, carrot or crown? Accreditation in nuclear medicine [Invited Review]
R J Burwood
Department of Nuclear Medicine, Royal Sussex County Hospital, Brighton BN2 5BE, UK

A standards programme for the mono-speciality of nuclear medicine was developed in the South East Thames Region and has since been adopted by the British Nuclear Medicine Society. Volunteer sites have invited trained survey teams to report on their delivery of nuclear medicine against organizational and radiopharmacy audit protocols, and to report upon their overall "assurance of quality" *viz* clinical audit, organizational structure, technical quality control and client satisfaction. The process has been regarded as threatening, offensive and a management tool. A majority of sites have found it educational and a stimulus to significant and beneficial change. This presentation argues that "accreditation" may confer on a department a hallmark of quality that will be sought as much by the provider as by the purchasers.

2.40 – 3.05 pm
Risk assessment in diagnostic and therapeutic nuclear medicine [Invited Review]
P J Mountford
Nuclear Medicine Department, Queen Elizabeth Hospital, Birmingham B15 2TH, UK

Measurements of radioactivity, dose or dose rate have allowed assessments to be made of the risks associated with diagnostic and therapeutic nuclear medicine, but there are areas where there is a deficiency in the published data. Although adult values of internal organ dose and effective dose equivalent (EDE) are available for all common radiopharmaceuticals, there are limitations to the biokinetic data on which they are based. Internal organ doses and EDE values for children at different ages are based on adult biokinetic data because of the lack of paediatric data. Estimates of the dose to an infant breast-fed by a mother undergoing a nuclear medicine procedure can be made for most radiopharmaceuticals. Estimates of the fetal dose up to about the third month of pregnancy are more reliable than at later stages when they are hindered by the absence of suitable anatomical models and biokinetic data. Critical groups of staff and members of the public exposed to diagnostic patients will not exceed current dose limits, but the official recommendations for ^{131}I patients after discharge are unnecessarily restrictive. A more rigorous study of the doses to members of the public from ^{131}I patients is required to assess the impact of a future reduction in dose limits.

3.05 – 3.13 pm
Interpretation of the ventilation/perfusion lung scan — an historical perspective on a modern conundrum [Paper]
P Kemp, D Tarver and V Batty
Department of Nuclear Medicine, Southampton University Hospitals, Southampton SO9 4XY, UK

The diagnosis of pulmonary embolism (PE) commonly relies on ventilation/perfusion (V/Q) scanning. "High-probability" and normal V/Q scans are reliable for confirming or excluding PE. The accuracy of less definite scans is reported to be improved by interpreting them with the aid of clinical findings, but it is unclear which features of the clinical history discriminate for PE. In this study, clinical histories were obtained from 197 patients referred for V/Q scanning for suspected PE. Scans were graded as high-probability, indeterminate, low-probability or normal. The clinical histories in the high-probability and normal groups were analysed. Pleuritic chest pain, haemoptysis or dyspnoea alone did not discriminate for the presence or absence of PE. Patients with both pleuritic chest pain and haemoptysis were slightly more likely to have a high-probability scan, but most patients with this combination had normal scans. Deep vein thrombosis or previous PE were significant

risk factors. No other combinations of features in the history were discriminators for PE. Despite this, patients given anticoagulating drugs before the V/Q scan were more likely to have high-probability scans than those who were not. Reasons for this are discussed. The clinical history is unreliable for predicting PE. Caution is advised when using clinical history to assist the interpretation of V/Q scans.

3.13 – 3.21 pm

The impact of lung scintigraphy on the management of suspected pulmonary embolism [Paper]

K A Lindsay and R F Bury
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To assess the impact on patient management of ventilation/perfusion (V/P) scintigraphy in suspected acute pulmonary embolism (PE), we performed a prospective study of 143 unselected patients attending for V/P scanning in a large teaching hospital. We used a dedicated request form to obtain relevant information, including the pre-test probability of PE based on clinical findings, and treatment intentions had scintigraphy not been available. Following the scan we sent a second form to the referring clinician to determine the effect of the scan on management. The scan results in each probability group were as follows: normal 48 (34%), low 44 (31%), intermediate 25 (17%), high 26 (18%). Clinicians felt that the result had influenced management in 126 (88%) cases, and in 82 (57%) the result enabled them to stop anticoagulant treatment or avoid it altogether. Other results are presented in detail. The study confirms the unreliability of clinical assessment in diagnosing pulmonary thromboembolism. While it is reassuring that clinicians place such great reliance on scanning, we (and they) are assuming that scintigraphy is an accurate test for PE. As in most UK centres, very few pulmonary angiograms are performed in our hospital to check this assumption.

3.21 – 3.25 pm

Evaluation of lung scan defects in patients with clinically suspected pulmonary embolism [Poster]

[1,2]R F Wang and [2]L Barritault
[1]Department of Nuclear Medicine, Fujian Medical College, 350004 Fuzhou, Peoples Republic of China and [2]Service de Médecine Nucléaire, Hôpital Laënnec, 75007, Paris, France

The aim of this paper is to assess the clinical validity of perfusion lung scintigraphy in the differential diagnosis of pulmonary embolism and other disorders with clinical signs and symptoms similar to pulmonary embolism, such as pulmonary arterial stenosis. Four patients (mean age 38 years; two males, two females) were examined using conventional perfusion lung scanning in six directions (posterior, anterior, two lateral and two posterior oblique views) following IV 129.5 MBq of $^{99}Tc^m$-MAA prior to therapy. There was an important segmental and lobar perfusion defect on scintigram. One demonstrated absent perfusion of lung on the left. In order to exclude other disorders as the cause of lung scan defects, pulmonary angiography was carried out and showed no findings of blood clots. However, there was a stenosis of 50–80% on the angiogram, which correlates well with abnormal perfusion deficits. To sum up, one should be especially aware of pulmonary vascular abnormalities in the absence of perfusion of a complete segment and lung, and pulmonary angiography and non-invasive tests for venous thromboembolism are required for those patients in whom there is strong suspicion of the presence of a disorder other than pulmonary embolism.

3.25 – 3.29 pm

Value and limitations of commercial software for ventilation–perfusion analysis [Poster]

D Sobic-Saranovic, S Pavlovic, N Kozarevic, V Bosnjakovic, M Veljovic and M Lekic
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The purpose of the study was to evaluate a commercial ventilation–perfusion (V–P) programme in different lung diseases. 30 patients were examined: two controls, 10 with pulmonary embolism (PE), six with chronic obstructive pulmonary disease (COPD), five with pulmonary infiltration (PI) and seven with lung carcinoma. The diagnosis was based on clinical symptoms, laboratory data, chest radiography, pulmonary function testing and V–P lung scan. Ventilation studies were performed with ^{133}Xe in standard dynamic modality ("single-breath" inhalation followed by 12 more 30 s images). Perfusion scintigraphy was performed with $^{99}Tc^m$-MAA in six standard projections. The commercial programme included evaluation of V/P, V–P, V/Q (Q-perfusion per unit lung volume image), V–Q ratio, functional images, $T_{\frac{1}{2}}$ of ^{133}Xe washout for both lungs. The mean value of V/P ratio in controls was 1.2 ± 0.6, in COPD 1.3 ± 0.37; it was significantly higher in PE (1.8 ± 0.77, $p < 0.05$). $T_{\frac{1}{2}}$ of ^{133}Xe was slightly increased in PE and statistically decreased in COPD in comparison with the controls. V/P was higher in PE and the half life of ^{133}Xe was longer in COPD. Functional images were useful in smaller V–P abnormalities. The technique requires patients' cooperation, thus excluding difficult patients and cases with poor counting statistics. Detection of hilar ventilation

abnormalities is limited because a patient is positioned in posterior projection only.

3.29 – 3.37 pm

The role of ventilation/perfusion scanning in identifying the appropriate lung for single lung transplantation [Paper]

M C Pearson
Department of Imaging, Royal Brompton Hospital, London SW3 6NP, UK

We aimed to define the individual function of each lung using V/Q scanning prior to single lung transplantation (SLT) without cardio-pulmonary by-pass. 25 patients (aged 29–59 years) were studied. 11 patients had restrictive lung disease, eight patients had emphysema and one patient had pulmonary hypertension. Eight further patients had cystic fibrosis or bronchiectasis precluding SLT but not affecting evaluation of ventilation/perfusion. The images were analysed using a simple computer program. Following background subtraction, the lungs were divided into three zones and the mean counts calculated, giving percentage values for each lung. The percentage lung ratios for ventilation and perfusion ranged from approximately equal to 68/32 for ventilation and 72/28 for perfusion. 19/25 patients had V/Q values matched within 5%. In six further patients, the values differed with a range of 6 to 16%. The left/right ratio for ventilation did not exceed 70/30 in any patient. Five patients underwent successful SLT, four having "the worst" lung and one, a marginally better lung transplanted. To avoid cardio-pulmonary by-pass, the divided lung function ratio for ventilation should be $< 70/30$. These results indicate that, in this study group, either lung could be transplanted without using by-pass.

3.37 – 3.41 pm

Patient waiting area doses and occupancy in a nuclear medicine department [Poster]

A S K Dzik-Jurasz and N W Garvie
Radio Isotope Department, Royal London Hospital, London E1 1BB, UK

Radiation doses in the patient waiting area were measured and the occupancy of the area noted, to determine whether any improvement in the distribution of patients might be necessary in respect of the ALARA principle. Thermoluminescent dosemeters (TLDs) were secured to the waiting area walls with clear tape in positions corresponding to bladder, shoulder and head height with the patient in a sitting position. Further TLDs were secured at 1.6 m and 2 m from the ground. One TLD was placed at the volumetric centre of the room, and a further four were positioned laterally. The time and place where the patient sat were recorded continuously over 3 weeks. A total of 103 patients used the waiting area. The total activity/time product was 29.9 GBq h. The mean product per day was 1.5 GBq h, with a mean per patient of 290 MBq h. The mean for all TLDs was 0.13 mGy. Two areas of high dose were detected over a region of two sets of two seats. The highest dose recorded was 0.8 mGy at bladder level, with a mean for those two seats of 0.38 mGy, and a mean of 0.26 mGy for the other set of two seats. There are no rules governing where patients sit within their designated area. Two foci of high activity were detected in our waiting area, which is in direct line of the television. This may cause small parts of a designated area to surpass the limits of dose for a controlled area. Steps might be required to redistribute this dose in keeping with the ALARA principle. Other departments are urged to perform similar studies.

3.41 – 3.49 pm

The construction of a standard reference for methionine PET using a computerized brain atlas [Paper]

C A J Romanowski, I Banos-Lekka, L Thurfjell, K Ericson, T Greitz and S Stone-Elander
Department of Neuroradiology, Karolinska Hospital, S-171 76 Stockholm, Sweden

An individually adjustable computerized brain atlas has been developed at the Karolinska Hospital, Stockholm. The individual's images can be reformatted into the standard anatomy of the atlas by a process of inverse transformation. 10 normal male volunteers (mean age 24.2 years) had both MRI and methionine PET studies of the brain. PET was performed following injection of 350–400 MBq of ^{11}C-methyl-L-methionine. T_2 weighted MR and summation PET images were transferred to a Sun SPARC workstation. The computerized brain atlas was adjusted using the anatomically rich MR images and transferred to the PET images for each individual. Each PET image was then reformatted by inverse transformation to fit the standardized brain. These standardized images were then summated and a set of mean images produced. This set of normal reference images may then be subtracted from a PET study of a patient with suspected intracranial pathology to reveal subtle changes. This is called the individual-mean subtraction process. The potential for the early diagnosis of brain tumours by this method will be discussed.

4.15 – 4.55 pm

Vascular Ultrasound

Harewood Suite I

4.15 – 4.23 pm

A comparison of angiography and intravascular ultrasound in the detection of peripheral atherosclerosis [Paper]

A N S Deaner, A A Cubukcu, M Lal, P Brooksby, P J Scott, U M Sivanathan and G J Williams
Non-Invasive Unit and Department of Radiology, Killingbeck Hospital, Leeds LS14 6UQ, UK

This study compares single-plane angiography of the distal aorta, iliac and common femoral artery with intravascular ultrasound (IVUS). 30 patients recruited to the Killingbeck Regression of Atheroma Study had both subtraction angiography and IVUS (using a 6F, 20 MHz probe) of these vessels. The angiograms and IVUS images were divided into four segments (distal aorta, common iliac, external iliac and common femoral) for analysis. Segments were graded according to disease severity: 0 = normal, 1 = wall irregularity on angiography or intimal thickening on IVUS, 2 = luminal narrowing < 30%, 3 = narrowing of 30–50%, 4 = narrowing > 50%. The findings of the two methods were compared. Of 109 segments analysed, there was complete agreement between methods in 24 segments (22%); in 65 segments (60%) there was either total agreement or the segments were graded within one grade of each other. There was a significant difference in grade (two grades or more) in 44 segments (40%), and of 54 segments that appeared normal on angiography 33 (61%) were Grade 2 or more on IVUS. We conclude that angiography frequently underestimates or misses atheroma that is apparent on IVUS.

4.23 – 4.31 pm

Does colour flow Doppler imaging have a role in the assessment of lower limb vasculature following percutaneous transluminal angioplasty? [Paper]

G J M Goh, A M Nicholson, G J Murphy and J N Johnson
Departments of Radiology and Vascular Surgery, Halton General Hospital NHS Trust, Runcorn, Cheshire WA7 2DA, UK

Percutaneous transluminal angioplasty (PTA) is normally performed for clinical symptoms of lower limb ischaemia with a proven stenotic lesion or occlusion. We instituted a study to assess whether routine colour flow Doppler (CFD) follow-up was of value following PTA. The questions addressed were whether CFD was more sensitive than clinical symptoms in detecting re-stenosis, whether early detection of this altered the clinical management, and whether CFD helped to distinguish between re-stenosis and other causes of pain such as osteoarthritis and neuropathy. PTA was performed in 43 limbs in 31 patients; there were 11 iliac angioplasties, and 32 superficial femoral angioplasties. Prospective follow-up for 1 year using clinical assessment and CFD at 6 weeks, 3 months, 6 months and 1 year were performed. Clinical symptoms recurred in 15 patients. Nine (60%) had abnormal CFD studies before the onset of clinical symptoms. 75% recurred within 6 months following PTA; 10 of these patients went on to have a second PTA. CFD is more accurate than simple out-patient tests and less invasive than arteriography. It has an important role to play in assessing lower limb vasculature following PTA, and could affect clinical management following PTA.

4.31 – 4.39 pm

The laryngeal mask — does it affect carotid blood flow? [Paper]

F L Flanagan, S A Corbett, R Page, D Moriarty and M Behan
Department of Radiology, University College of Dublin, Institute of Radiological Sciences, Mater Misericordiae Hospital, 52 Eccles Street, Dublin 7, Ireland

Since its development in 1980 by Dr A I J Brain, over five million patients in Europe have had a laryngeal mask (LM) inserted as a form of airway management during anaesthesia. The LM maintains the airway by sitting in the oropharynx with the laryngeal aperture below. An inflated cuff holds the laryngeal mask in position. The effects of cuff inflation on carotid bulb dimensions and haemodynamics were reviewed. Using a colour-flow duplex Doppler ultrasound machine and a 5 MHz probe, the peak systolic velocities and cross-sectional areas of the carotid bulb on the right and left side were obtained for 18 patients before and after inflation of the laryngeal mask cuff. All the information was stored on a VCR video tape for further

analysis. In all 36 carotid estimates of percentage area and flow change, a poor positive correlation coefficient of $r = 0.5$ was obtained. The correlation was stronger in the group aged over 60 ($n = 10$) ($r = 0.65$). Wide individual percentage area change was noted. Early findings indicate some alteration in cross-sectional area and flow in the elderly population. The consequences of this may be significant in the random use of the LM, especially in "at risk" atherosclerotic patients.

4.39 – 4.47 pm

The fate of the long saphenous vein in patients undergoing saphenofemoral disconnection and multiple phlebectomies [Paper]

[1]M C De Nunzio, [1]S C Whitaker, [2]D M Baker and [2]P W Wenham

Departments of [1]Radiology and [2]Vascular Surgery, University Hospital, Nottingham NG7 2UH, UK

In order to assess the quality of the long saphenous vein and therefore its suitability as an arterial bypass conduit following saphenofemoral disconnection and multiple phlebectomies, 36 patients (44 legs), who 3 years previously had undergone successful saphenofemoral disconnection with extensive phlebectomies for varicose veins, were examined. Colour Doppler ultrasound was used to assess the long saphenous vein for patency, calibre and wall thickening. The long saphenous vein was patent from just below the groin to below the knee in 34 of the 44 legs (77%) and to the ankle in 19 legs (43%). The mean diameter of patent vessel just below the groin was 4.1 mm (SD 1.5), just above the knee 4.4 mm (SD 1.2), below the knee 4.1 mm (SD 0.85) and at the ankle 3.7 mm (SD 1.0). In at least one of these four sites in 16 legs the vessel was tortuous, and in six legs the venous wall was thickened. However, no significant dilatation was seen along any of the patent vessels. In 77% of cases which have previously undergone varicose vein surgery, sufficient long saphenous vein is available for use of a femoral–popliteal vein graft. In 43% of cases the patent vein was long enough to allow femoral distal graft. The suitability of the long saphenous vein for use as a vein graft can readily be assessed using colour Doppler ultrasound.

4.47 – 4.55 pm

The incidence of jugular venous thrombosis in post-operative patients with jugular venous catheters [Paper]

B J Lewandowski, R L Garnett, D Hooper, P Reid and R DeVermette

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We evaluated the incidence of jugular and deep venous thrombosis in post-operative patients (with jugular venous lines) undergoing major abdominal surgery. Between November 1991 and May 1993 a total of 89 patients (16 F, 73 M) undergoing major abdominal vascular surgery (occlusive disease and/or aneurysm repair) were evaluated sonographically for jugular and deep venous thrombosis. The early post-operative examination was usually performed on the second day when the jugular venous catheter was removed. The late scan was usually performed on the ninth post-operative day prior to discharge. 28 patients were examined during the early post-operative period. 58 were examined both on the early and late dates, and only three were examined at a later date only. The overall incidence of jugular vein thrombosis was 87.6% (78/89) and of deep venous thrombosis 8.9% (8/89). In one case of jugular vein thrombosis there was total occlusion of the jugular vein, whereas in the other patients, the clot was either absent, smaller or only slightly larger on the follow-up examination. High resolution sonography is sensitive in diagnosing the presence of thrombosis. Although the incidence of jugular vein thrombosis is much higher in the post-operative period than previously expected, the initial finding of a small clot should not be alarming since most of these resolve spontaneously. The subsequent development of jugular vein occlusion is rare.

4.15 – 5.37 pm

Modern Radiotherapy: (a) Paediatrics; (b) Urology

Bramham Suite

4.15 – 4.40 pm
The current management of paediatric brain tumours [Invited Review]
R E Taylor
Cookridge Hospital, Leeds LS16 6QB, UK

Brain tumours account for approximately 20% of paediatric malignancies. A wide variety of histologies occur, and experience in the management of individual types is often limited. Radiotherapy (RT) remains a very important treatment modality and is technically challenging. Many children require craniospinal RT, most commonly for medulloblastoma. Precision is important to avoid insufficient dose to areas of potential metastatic disease and excess dose to critical organs such as the lenses and spinal cord. Whether pretreatment with chemotherapy improves survival is the subject of an ongoing international trial. Low grade astrocytomas may be extremely slow growing. It is possible that following surgery they can be managed by an initial observation period, reserving RT for those which progress. High grade astrocytomas and brain stem gliomas are aggressive, and usually refractory to RT and chemotherapy. The role of hyperfractionation is being explored. Treatment of very young children less than 3 years old is a particular challenge. Immobilization for RT frequently requires daily anaesthesia. There is concern regarding the late effects of RT on neuropsychological development. Current strategies involve the use of chemotherapy to try to delay RT until after the third birthday, hopefully reducing late effects. Children with brain tumours and their families can face many problems, and they should be managed by a multidisciplinary paediatric oncology team.

4.40 – 4.44 pm
Quality assurance in craniospinal irradiation: accuracy of shielding block positioning for cranial irradiation [Poster]
J Owens
Regional Radiotherapy Centre, Cookridge Hospital, Leeds, UK

Eight patients diagnosed as having either medulloblastoma or acute lymphoblastic leukaemia were entered into the study. Whilst undergoing total craniospinal irradiation each patient was imaged on six occasions during the course of radiotherapy. The portal radiographs obtained were directly compared with the radiographs taken during treatment planning and quantitative evaluation was made of discrepancies in the daily positioning of the lead alloy blocks. The average error in the positioning of the blocks was found to be less than 5 mm in any direction. However, of the occasions when the errors incurred were greater than 5 mm, 26% occurred at the border which is vital for accurate shielding in the region of the cribriform plate. Furthermore, nearly half the errors at this border resulted in overshielding. Analysis of the results revealed that the errors resulted from a directional shift in the position of the block rather than a rotational misalignment. The results of this study suggest that the use of fixed lead alloy blocks on Perspex sheets could reduce inaccuracies in the positioning of shielding blocks. It is also recommended that radiographers receive more feedback and become actively involved in checks made on the quality of the treatment delivery.

4.44 – 4.48 pm
Imaging features of malignant rhabdoid tumour of the brain [Poster]
M Hardjasudarma, M Fowler, B Willis, W Stewart, J Lecky, R McClellan and H Hollenberg
Departments of Radiology, Pathology and Surgery (Neurosurgery), Louisiana State University Medical Center in Shreveport, Shreveport, LA 71130-3932, USA

A 4-year-old girl presented with right hemiparesis. She was studied with CT, MRI (1.5 T), and cerebral angiography. Surgery was performed. The histopathological tests included electron microscopy and immunohistochemistry. CT and MRI revealed a large, inhomogeneous left cerebral mass with necrosis and enhancement. Cerebral angiography showed marked mass effect. Surgery was complicated by severe haemorrhage. Histopathological studies were positive for malignant rhabdoid tumour. This is uncommon in the brain, with only five cases reported world-wide, accompanied by imaging which is dramatic but non-specific. The entity should be included in the differential diagnosis of large malignant intracranial tumours of childhood. In selected cases, pre-operative embolization may be advantageous.

4.48 – 4.52 pm

Non-viral progressive multifocal leukoencephalopathy (PML) and cerebral sinus thrombosis: treatment-related complications in lymphomas and non-Hodgkin's lymphomas of childhood [Poster]

W Küker, J Reul, R Mertens, V Ramaekers and A Thron
Departments of Neuroradiology and Paediatrics, University Hospital, Rhein-Westfalen Technische Hochschule, D-52057 Aachen, Germany

We report two children with acute manifestation of lymphomas. Following cytostatic therapy the children suffered from severe CNS toxic side-effects. The first patient was treated with L-asparaginase (L-A) and methotrexate (MTX). Initial CCT and CSF examination were normal. She developed acute hemiparesis and epileptic seizures followed by progressive coma. On T_2 weighted MRI, multifocal subcortical areas with increased signal were seen. The most extensive lesion showed slight enhancement after administration of contrast medium of T_1 weighted images. Differential diagnosis was lymphatic infiltration, PML or drug-related toxic encephalopathy. After dose reduction of the cytostatic agents, the child improved quickly and the changes seen on MRI returned nearly to normal, thus suggesting a toxic aetiology. The second patient developed recurrent epileptic seizures during the intial course of the chemotherapy (again receiving L-A and MTX). Initial CCT was normal. On MR images, a thrombosis of the left transverse and sigmoid sinus with temporal brain oedema was seen. The thrombosis was confirmed by intra-arterial angiography. The patient improved after dose reduction and heparinization. Up to now we have observed similar findings in three other cases. We suggest a causal relationship between the cytostatic therapy using high doses of L-A and MTX and the complications described. L-asparaginase is known to cause venous thrombosis. However, it remains unclear whether MTX or L-A alone or the combination of both drugs caused the PML-like alterations of the brain in the first case. The knowledge of these complications and the differentiation from true papovavirus-induced PML or lymphoma is important, because dose reduction or alteration of the drug regimen might lead to complete recovery. MRI facilitates this differentiation, but in some cases angiography is still necessary.

4.52 – 5.00 pm

Tumour doses in targeted mIBG therapy [Paper]

M Tristam, A Alaamer, J Fleming, V Lewington and M Zivanovic
Department of Nuclear Medicine, Southampton General Hospital, Southampton SO9 4XY, UK

Assessment of absorbed tumour doses in targeted radionuclide therapy with [^{131}I]metaiodobenzyl-guanidine was made using [^{123}I]mIBG, with sequential scintigraphic imaging. 12 adult patients with phaeochromocytoma were studied; 18 different lesions were quantified and, as some patients underwent repeated investigations, 30 independent measurements were obtained. Planar gamma camera images were acquired for up to 70 h post injection, which allowed calculation of biological half-life. 24 h absolute measurement of activity, obtained from a SPECT study, served as calibration point for planar uptake evaluation. Attenuation correction, using CT images or standard body outline technique, was applied. Viable tumour volume was calculated directly from SPECT, using corrections derived from phantom measurements. Results of diagnostic studies with tracer [^{123}I]mIBG were adjusted for therapeutic activities of [^{131}I]mIBG. Measured tumour volumes were between 13 and 400 ml. Mean specific initial uptake was calculated as $U_0 = 0.037 \pm 0.019\%$ per 1 ml of viable tumour, mean effective half-life $T_1 = 33 \pm 7.8$ h. For typical administered activity of 7 GBq, tumour dose $D = 13.6 \pm 10.3$ Gy, independent of tumour volume, would be delivered. Calculated doses ranged between 3 and 36 Gy. This spread of values is attributable to large differences in initial uptake, $0.012 \leqslant U_0 \leqslant 0.080\%$ ml^{-1} and, to a lesser extent, differences in effective half-life, $19 \leqslant T_1 \leqslant 50$ h. The above method of dose evaluation was found to be repeatable and operator-independent.

5.00 – 5.25 pm

Palliative therapy of urologic cancer [Invited Review]

[1]S D Fosså, [1]S Ous and [2]H Wæhre
[1]*Department of Medical Oncology & Radiotherapy and* [2]*Department of Surgical Oncology, The Norwegian Radium Hospital, 0310 Oslo, Norway*

The literature and personal experience are reviewed concerning the type and the efficacy of palliative treatment in urologic cancer. The principal aim of palliative treatment is relief of distressing symptoms, thereby hopefully increasing the patient's quality of life. Principally this concerns both physical and psychological problems. Prolongation of life is only a secondary aim in most cases. *Bladder cancer:* In advanced muscle-invasive bladder cancer improvement of micturition problems has been obtained in 30–50% of the cases, both by short-lasting moderate dosed radiotherapy or by cisplatin-based chemotherapy. Before starting non-surgical oncological palliative treatment modalities, the urologist should always be consulted as to whether surgery (TUR-B, partial or total cystectomy, urinary diversion) can contribute to overall palliation. *Prostate*

cancer: Palliation of metastic bone pain is achieved in 30–70% of the cases by external radiotherapy or radioactive isotopes (^{89}Sr, ^{153}Sm). External radiotherapy seems to be equally effective if given by single (eventually repeated) fractions (8–10 Gy) or by multiple fractions (4 Gy × 5 in 1 week, 3 Gy × 10 in 2 weeks). Spinal cord compression can be effectively relieved if the patient is referred to a team of neurosurgeon, orthopaedic surgeon and radiotherapist early during the clinical course (before the establishment of paralyses). Pelvic pain due to large soft-tissue lymph node metastases is often palliated by external beam radiotherapy. Second line hormone treatment with *e.g.* glucocorticoids or MPA yields palliation in 20–30% of the patients. *Testicular cancer:* Local radiotherapy in seminoma patients and/or surgical resection of large tumour masses may lead to pain relief in these often heavily pretreated patients. The role of palliative chemotherapy is poorly defined. *Renal cell carcinoma:* Brain metastases, retroperitoneal soft tissue masses and osteolytic bone metastases most frequently require palliative therapy. The optimal fractionation pattern and most effective target dose remain poorly defined. Consideration of surgical palliation is of particular importance in this malignancy. *Penile cancer:* Even in advanced cases multimodality treatment (surgery, radiotherapy, chemotherapy) may result in local control of large ulcerating tumours. In conclusion, there is evidence that palliation of distressing symptoms can be achieved in 40–70% of patients with urologic cancer with the combined efforts of surgeons and oncologists. The role of such palliation for improvement of quality of life is less clear and needs to be clarified in future investigations using modern instruments for quality of life assessment.

5.25 – 5.33 pm

Treatment outcome and prognostic factors in spinal cord compression due to prostate carcinoma [Paper]

R A Huddart, B Rajan, M Law and D P Dearnaley
Academic Department of Radiotherapy, Royal Marsden Hospital, Sutton, Surrey SM2 5PT, UK

Prostate carcinoma is one of the commonest causes of spinal cord compression (SCC). To examine treatment outcome and prognostic factors we have identified 69 prostate carcinoma patients with SCC treated in this department. At presentation 40 (58%) of patients were non-ambulant and 52% were catheterized. Diagnosis was established by myelography in 42% and MRI in 47%. MRI detected significantly more patients with multiple sites of compression (51% *vs* 7%). SCC was present at the initial diagnosis in 13 patients and 17 patients had received no hormone treatment prior to diagnosis. 94% of patients received radiotherapy and 14 (20%) additional surgery. Following treatment, 36 (52%) of patients showed functional improvement of motor power with 25/40 (63%) of non-ambulant patients becoming ambulant. 77% of patients who had eventual functional improvement had some improvement of power by 7 days. On multivariate analysis a single level of compression, no prior hormone treatment, and young age (< 65) predicted for better neurological outcome. The median survival was 7 months, with 25% surviving 2 years. Patients with no prior hormone treatment had a median survival of 42 months. Other predictors of better survival on multivariate analysis were a single site of compression and Hb > 12 g. In conclusion, treatment of SCC in prostate cancer results in improved function in the majority of patients, with some long-term survivors, especially in good performance status patients with no prior hormone treatment. Early improvement in motor power is a strong predictor of subsequent functional improvement. MRI detects more multiple sites of compression and has lower morbidity so should be considered the investigation of choice.

5.33 – 5.37 pm

TRUS imaging score, log PSA/volume and digital rectal examination as predictors for prostate cancer [Poster]

F M Witham, M J Michell, M J Coptcoat, K R Abrams and A Smith
Department of Diagnostic Radiology, King's College Hospital, London SE5 9RS, UK

To define the indications for TRUS-guided biopsy of the prostate, 100 of 335 patients undergoing transrectal ultrasound (TRUS) had ultrasound-guided 18G needle biopsy performed for suspicion of prostate cancer raised by digital rectal examination (DRE), prostate specific antigen (PSA) level, or imaging. DRE and imaging were scored as 1, 2 and 3 for low, intermediate and high suspicion of malignancy. Needle biopsy and operative histology results were collected. Log PSA plotted against volume gave a log–linear equation through the benign data. The majority of the malignant data lay below the 97.5% benign confidence limit. DRE scores of 1, 2 and 3 gave positive predictive values for malignancy of 32%, 60% and 75% respectively. Imaging scores of 1, 2 and 3 gave positive predictive values for malignancy of 27%, 60% and 88% respectively. χ^2 test analysis of the imaging score table gave $p < 0.0001$. Log PSA/volume failed to distinguish the benign from malignant histology in imaging Group 1. In patients with a raised PSA or suspicious DRE, imaging score is the best predictor of malignancy. These results suggest that when imaging is normal, log PSA/volume cannot be used to reduce the number of benign biopsies performed.

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Tuesday 24 May

9.00 – 10.17 am

Oncology Imaging I

Royal Hall

9.00 – 9.25 am
Decision making in diagnostic oncology [Invited Review]
J A Spencer
Department of Radiology, St James's University Hospital, Leeds LS9 7TF, UK

Decisions made in the management of cancer patients are concerned with initial diagnosis, staging of disease and subsequent surveillance during treatment and follow-up. For several common cancers screening programmes are in progress or under consideration. The guiding principles involved in the choice of investigations will vary for individual cancers and between different clinicians. A common understanding of management goals for referring clinician and investigating radiologist is thus essential and works best within a framework of regular clinico-radiological and pathological reviews. These guiding principles will be discussed in the context of simple statistical assessments of imaging test performance, the probability of the test result being correct and its consequence for clinical decision making. Design of imaging protocols and choice of follow-up test intervals will be reviewed in relation to tumour behaviour and cumulative relapse models. Subjective factors weigh heavily in the decision process. The ability of patient and clinician to live with uncertainty influences the choice of a "wait and watch" or "wait and see" approach to surveillance. The need for a continuing review of practice will be emphasized.

9.25 – 9.33 am
Causes of delay in the diagnosis and treatment of spinal cord and cauda equina compression [Paper]
D M Ritchie
Department of Clinical Oncology, Weston Park Hospital, Sheffield S10 2SJ, UK

Prompt treatment is an important determinant of successful management of spinal cord compression (SCC) or cauda equina syndrome (CES) caused by metastatic malignancy. The aim of the study was to establish why delays in treatment with radiotherapy occur. A retrospective review of patient notes was carried out and a prospective questionnaire of new cases detailing management devised. 32 patients have entered the study, 30 had SCC and two CES, and 41% known vertebral metastasis. The mean duration of symptoms was backache 55 days, muscle weakness 25 days, sensory symptoms 12 days, sphincter disturbance (17 patients) 4 days and 24 patients were non-weight bearing (mean 5 days). Patients consulted GPs on average 13 days prior to diagnosis. One third were correctly diagnosed at first presentation. Hospital admission was to a unit other than oncology or neurosurgery in 44% of cases. The mean wait for diagnostic magnetic resonance imaging was 2 days and the mean delay in transfer for treatment 3.5 days. Most patients with SCC and CES have a long history of backache and neurological symptoms. Letters to GPs warning of high risk patients, relevant symptoms and appropriate referral may improve management. Better communication between other medical specialties and diagnostic radiology is required.

9.33 – 9.41 am
MRI in differentiating benign from malignant soft tissue masses of the extremities [Paper]
Lj Poleksić, M Atanacković and D Zdravković
Magnetic Resonance Center, University Clinical Center, 11000 Belgrade, Serbia

We wished to evaluate the ability of magnetic resonance imaging (MRI) to differentiate benign from malignant soft tissue masses of the extremities. 32 histologically confirmed soft tissue lesions of the extremities were examined on a 1.5 T MR imager (Magnetom, Siemens) with T_1 and T_2 weighted images in two orthogonal planes. Masses were evaluated for localization, size, margins, signal intensity (SI) and homogeneity. The majority of the lesions were in the lower extremity (81.2%) but the frequency of malignant lesions was no different from that of the benign ones. More

malignant tumours were larger than 1000 ml than were benign masses (38.4%:14.2%). Malignant and benign lesions had irregular margins in 46.1% and 50% of cases, respectively. Most of the lesions (78.1%) were isointense relative to surrounding muscles on T_1W images, while in 93.8% they were hyperintense on T_2W images. 38.4% of malignant tumours had homogeneous SI, while 31.2% of benign lesions had inhomogeneous SI on both T_1W and T_2W images. We found no significant statistical difference in any of the parameters analysed. We concluded that MRI does not enable benign soft tissue masses of the extremities to be differentiated from malignant.

9.41 – 9.45 am

MRI evaluation of the response of tumour perfusion to radiotherapy [Poster]

J Gerber, H Baddeley, K Piggot and M Saunders
Paul Strickland Scanner Centre & Marie Curie Research Centre, Mount Vernon Hospital, Northwood HA6 2RN, UK

The vasculature of solid tumours is an important factor mediating their response to treatment. Blood flow within tumours is markedly heterogeneous, with areas being underperfused and hypoxic. In animal tumour models with radiotherapy, the pattern of perfusion is known to vary. To evaluate the pattern of human tumour perfusion, we used single-pass gadolinium DTPA dynamic imaging to monitor changes in maximum intensity/time ratios (MITRs) in different areas of tumour before and during radiotherapy. In order to achieve high spatial and good temporal resolution T_1 weighted gradient echo images, we have employed a 'cut and paste' technique which allows collection of the central phase-encoding cycles only. A complete matrix is restored by 'pasting in' higher order cycles from a control scan performed prior to contrast injection. The selected slice is collected dynamically over a period of 1 min, with a scan every 2 s. The first scan is used as reference, with the data analysed as a function of time and position. These studies have been performed on an Elscint Gyrex 2T D1x.

9.45 – 9.53 am

Rapid acquisition MRI of interstitial laser photocoagulation of *in vivo* rat liver: an imaging–pathological correlation [Paper]

H R S Roberts, M Clemence, M Paley, G Buonaccorsi, M A Hall-Craggs, S G Bown and W R Lees
National Medical Laser Centre and Department of Radiology, University College London Hospitals, London WC1E6JJ, UK

Interstitial laser photocoagulation (ILP) is the destruction of deeply situated lesions by laser energy deposited into them via percutaneously inserted optical fibres. We are developing rapid acquisition magnetic resonance imaging (RA-MRI) of ILP of liver tumours to allow precise control of treatment delivery. Preliminary *in vitro* studies showed a T_1 weighted spin echo (T_1WSE) to be the most promising sequence. We therefore used it for RA-MRI (scan time 20 s) of developing laser lesions in rat liver *in vivo*. RA-MRI showed: (1) a progressively enlarging area of low signal intensity during ILP; (2) contraction of this low signal area when the laser was switched off, to leave a central signal void and surrounding high signal zone. Imaging–pathological comparison showed that at the end of treatment low signal area corresponded closely to the area of necrosis. RA-MRI with a T_1WSE sequence demonstrates the size of the lesion created in *in vivo* rat liver by ILP at the time of the procedure. We intend to use this sequence initially to develop RA-MRI monitoring of ILP of hepatic metastases and later to extend it to other ILP targets such as prostate and lung cancer.

9.53 – 10.01 am

MRI of squamous cell carcinoma of the oral cavity [Paper]

R S D Campbell, G Wilson, E Baker, A J Chippindale and N Maclean
Departments of Radiology and Plastic Surgery, Newcastle General Hospital, Newcastle on Tyne NE4 6BE, UK

We aimed to evaluate MRI in the preoperative assessment of patients with squamous cell carcinoma of the oral cavity. Preoperative MRI scans were performed in 44 patients, with coronal and axial T_1 weighted and coronal fat-suppressed T_2 (STIR) sequences. Surgery included excision of the tumour, together with either a radical or modified neck dissection; radiological/pathological correlation was available in all cases. 24 patients had lesions of the floor of the mouth, 15 of the tongue and five of the retro-molar trigone. 33 patients had primary carcinomas, and 11 had recurrent disease. MRI detected the lesion in 36 patients. Associated salivary gland abnormality was seen in 17 patients. A total of 772 nodes were excised, varying in size from 1–29 mm. MRI detected all 23 metastatic nodes identified in 12 patients. MRI has been shown to be reliable in demonstrating carcinomas of the oral cavity, and we give a detailed description of the correlation between MRI appearances and pathological findings, including the tumour staging, and local spread, together with an account of those cases where MRI did not demonstrate the area of abnormality, or was misleading. The role of MRI in pre-operative staging of oral cavity carcinomas is discussed.

10.01 – 10.09 am

Evaluation of fast STIR MR imaging in the assessment of oropharyngeal cancer [Paper]

[1]R S Davies, [1]R J Hammond, [1]J Curtis, [2]C Bierne, [2]J Brown, [1]H E Lewis-Jones and [1]J M Meaney
Departments of [1]Radiology and [2]Maxillo-Facial Surgery, Aintree Hospitals, Rice Lane, Liverpool L9 1AE, UK

We present more than 30 cases of oropharyngeal cancer which were evaluated pre-operatively by CT and MRI. Dynamic enhanced CT, fast STIR, fast T_2 spin echo and T_1 weighted spin echo before and after gadolinium contrast medium were compared. All images were performed within 10 days of surgery. Images were reviewed independently by a radiologist experienced in head and neck imaging. The separate sequences were scored for a variety of features including tumour size, boundary definition, invasion of adjacent structures, conspicuity, lymph node involvement and bone involvement. Comparisons were made with clinical assessment, including examination under anaesthetic, and ultimately with detailed histological analysis in all cases. The primary tumours were most accurately evaluated on fast STIR images. CT continued to provide good anatomical maps of the region with excellent bone detail, but all the evaluated scans had a poor predictive value for bone invasion. Both CT and STIR were comparable in their assessment of nodal involvement and were superior in this respect to the remaining pulse sequences. We believe fast STIR to be the imaging sequence of choice in the evaluation of oropharyngeal tumours.

10.09 – 10.17 am

MR imaging of pharyngeal neoplasms with fast and ultrafast sequences: comparison of CT and MRI [Paper]

P Held, A Geissler, B Denner and H Albrich
Department of Diagnostic Radiology, University Hospital of Regensburg, 93042 Regensburg, Germany

The aim of this study was to compare the diagnostic value of CT and MRI in the evaluation of pharyngeal tumours. Furthermore, the MR imaging protocol had to be optimized including 2D and 3D gradient echo sequences. We performed CT and MRI in 871 patients with neoplasms of the pharynx. MRI yields better results than CT in the detection of pharyngeal neoplasms. The differentiation of tumour and inflammatory tissue is best achieved using MRI. Contrast-enhanced 3D gradient echo sequences improve the diagnostic value of MRI of the nasopharynx. Fast and ultrafast 2D MR sequences increase the contrast between orofacial tumours and surrounding tissues. Functional MR images (phonation studies) are attainable using ultrafast MR sequences, thus enhancing the diagnostic value of MRI in the case of the hypopharynx. In conclusion, MRI is the imaging modality of choice in the evaluation of pharyngeal neoplasms. Conventional T_2 weighted spin echo should be replaced by fast T_2 weighted spin echo sequences. 3D gradient echo sequences should be integrated in the MR imaging protocol of the nasopharynx. Fast and ultrafast 2D gradient echo sequences should be applied in the evaluation of tumours of the oropharynx and hypopharynx.

9.00 – 10.21 am

Advances in MRI & Cardiovascular MRI

Ripley Suite

TUESDAY

9.00 – 9.25 am
New insights from MR; functional brain imaging [Invited Review]
B S Worthington
Department of Academic Radiology, University of Nottingham, Nottingham NG7 2UH, UK

The brain possesses anatomically distinct processing regions whose location, activity and organization underpin a distributed processing functional model. That there is a tight coupling between neuronal activity, energy consumption and regional blood flow is now well established and activation studies using imaging techniques by assessing the local response of brain metabolism or haemodynamics induced by internal or external stimuli map the underlying anatomical substrate. High speed functional MR techniques have been developed which are sensitive to changes in blood volume, intrinsic tissue perfusion through a T_1 effect and changes in blood oxygenation, specifically the relative amount of paramagnetic deoxyhaemoglobin reflected in signal changes on T_2^* weighted images. Besides fundamental contributions to cognitive neuroscience, such studies have clinical value *e.g.* assignment of hemispheric language dominance and mapping the relationship of the motor cortex to structural pathology. Assessment of changes in regional haemodynamics by EPI after injection of contrast agents have clinical utility in ischaemia and tumours. The vascular uptake and breakdown of the blood brain barrier (BBB) contribute to the contrast uptake curves in tumours. Indices reflecting tissue vascularity and permeability of the BBB can be derived which have clinical application both in tumour staging and assessment of treatment response.

9.25 – 9.33 am
FASTCARD: Preliminary results of a fast cardiac imaging sequence [Paper]
P Ignotus, M Graves, S A Powell, A Wilson and C W Heron
Department of Magnetic Resonance Imaging, St George's Hospital, Blackshaw Road, London SW17 0QT, UK

FASTCARD is a multiplanar ECG-gated fast gradient echo sequence using segmented k-space data acquisition to allow images at 7–12 phases of the cardiac cycle to be acquired within a single breath-hold. A typical sequence with a TE of 3 ms, a TR of 11 ms, and eight phase-encoding views per cardiac trigger takes approximately 12 s for eight cardiac phases at 256 × 128. Myocardium-to-blood contrast is double that of conventional gradient echo sequences. We used multiple contiguous FASTCARD acquisitions to quantitatively assess left and right ventricular function. With prototype cardiac analysis software we have used short cardiac axis, multi-phase FASTCARD images to measure left and right ventricular stroke volumes in normals and in patients with abnormal cardiac function. Volumetric measurements were validated by cine phase contrast velocity mapping in the ascending aorta and pulmonary artery and by comparing left and right ventricular stroke volumes. Preliminary results in eight subjects of stroke volumes determined by both techniques show good correlation (left: $r = 0.992$, S.E.E. = 6.3 ml; right $r = 0.963$, S.E.E. = 5.6 ml). Wall motion and thickening can also be evaluated. We conclude that FASTCARD is an effective tool for rapid functional cardiac imaging.

9.33 – 9.41 am
3D reconstruction from MR images in complex congenital heart disease [Paper]
U M Sivananthan, J P Ridgway, A A Cubukcu and K Bann
MRI Unit, St James's University Hospital, Leeds LS9 7TF, UK

We have performed 3D reconstruction of 2D MR image data obtained from patients with a range of complex congenital abnormalities of the heart in order to assess its role in the interpretation of cardiac MRI data and in the planning of subsequent surgery. 3D reconstruction has been performed on images from 23 patients (complex, left-to-right shunts: three; double outflow RV: two; transposition: three; VSD Eisenmenger: four; Fallots: six; trun-

cus: one; RVOT abnormalities: four). 2D ECG-gated spin echo images are acquired using a 1.0 Tesla Siemens Magnetom 42SP MRI system and are networked to a stand-alone Allegro 3D workstation (ISG Technologies Inc.). 3D objects corresponding to the myocardial wall and blood lumen are generated and colour-coded. The 3D objects are interactively rotated and cut away to demonstrate the abnormality. Supplemental 2D images are generated using a fast multiplanar reformatting package. In all cases 3D reconstruction demonstrates the abnormalities better than the original 2D image data, either confirming or modifying the diagnosis obtained from 2D images. In three cases, 3D reconstruction provided additional information which has modified subsequent surgical management. 3D reconstruction of cardiac MRI data improves the demonstration of complex anatomy and is invaluable in surgical planning.

9.41 – 9.49 am
Hypertrophic cardiomyopathy: assessment by echocardiography and magnetic resonance imaging at 1.5 Tesla [Paper]
A Devlin, N R Moore and I Ostman-Smith
Departments of Paediatric Cardiology and Radiology, John Radcliffe Hospital and University of Oxford, Oxford OX3 9DU, UK

We compared the measurement of left ventricular wall thickness and muscle mass by echocardiography and MRI in hypertrophic cardiomyopathy. Nine patients were studied (six males, three females; age 14–45 years). The anterior septum and posterior free wall were measured on M-mode images at the level of the tips of the mitral valve. The posterior septum and anterior free wall were measured on short axis views. Left ventricular muscle mass was derived using Devereux's formula. Contiguous 10 mm short axis 35° flip angle cine gradient recalled echo MR images were acquired from the apex to the base of the left ventricle. The maximal thicknesses of the septum and free wall were measured and muscle mass was estimated. There was close correlation of measurements of the septum by M-mode echocardiography and MRI. The correlation of free wall thickness was less good, possibly a result of imprecise section orientation. There was no correlation between muscle mass estimates. Echocardiography and MRI provide equivalent measurements of the septum. MRI provides better images of the free wall and a direct estimate of muscle mass. These are important diagnostic parameters in hypertrophic cardiomyopathy.

9.49 – 9.57 am
MRI of post-operative complications of the thoracic aorta [Paper]
P Murphy, D Pressdee, D Prince and J Wisheart
Departments of Clinical Radiology and Cardiac Surgery, Bristol Royal Infirmary, Bristol BS2 8HW, UK

We present 10 patients who developed a widened mediastinum after: (1) aortic valve replacement; (2) coronary artery bypass surgery; or (3) aortic root replacement for either aneurysmal dilatation, aortic dissection or rupture secondary to endocarditis. Though T_1 spin echo sequences demonstrated the pathology in each case, turboFLASH images obtained after giving gadolinium contrast medium prove the most informative in elucidating the extent and nature of the problem. False aneurysms of the ascending aorta, whether from damage due to the placement of a clamp previously or from the site of a coronary artery bypass graft insertion, were exquisitely demonstrated and the development of dissection flap and aneurysmal dilatation of the aortic root were also well seen. Demonstration of aortic regurgitation was also possible despite drop-out of signal from prosthetic aortic valves, and added information such as presence or absence of haemopericardium and left ventricular function could also be gained. We conclude that MRI is the modality of choice in the investigation of widening of the ascending aorta in the patient who has had previous surgery to either the aortic valve or the ascending aorta.

9.57 – 10.05 am
Pulmonary angiography and direct imaging of embolus (PADIE) using breath-hold Magnetic Resonance Imaging [Paper]
A Moody, S Bolton, P Emberton, M Horsfield and G Cherryman
University Department of Radiology, Leicester Royal Infirmary, Leicester LE1 5WW, UK

Recently there has been increasing interest in the direct visualization of pulmonary emboli (PE). Similarly the first reports of the clinical use of pulmonary MRA are being published. We have developed a MR technique that allows both pulmonary angiography and direct visualization of emboli. We used a magnetization-prepared rapid gradient echo (MP-RAGE) technique manipulated to perform pulmonary angiography or direct embolus imaging. During breath-hold imaging two contiguous blocks of images were obtained through the right and left pulmonary arteries, then repeated for direct embolus imaging. All images were post-processed using routinely available software. The

sequence was optimized using five normal volunteers. So far, five patients with a strong clinical history for PE have been scanned using this technique. Imaging in normal subjects visualized vessels down to the fifth order branches. The right-sided vessels are better demonstrated as there is less cardiac overlap. Inclusion of a direct coronal slab allows good visualization of the main proximal vessels, as well as vessels placed laterally. One patient demonstrated a large embolus within the right basal artery corresponding to a matched V/Q defect. This resolved after three weeks treatment. In two other patients MRA or direct embolus imaging defects have corresponded with V/Q abnormalities. Two scans were normal. This is the first simple pulmonary MRA technique that includes direct imaging of intravascular emboli. Its use in detection and therapeutic management of symptomatic, and possibly asymptomatic, patients requires further careful comparative studies with the imaging techniques already available to us.

10.05 – 10.13 am

To MRA or TFA? A comparison of Magnetic Resonance Angiography, angiography and duplex ultrasound of the peripheral arteries [Paper]

P Murphy, S Whitehouse, S Davies, P Lamont and R N Baird

Departments of Clinical Radiology, Medical Physics and Surgery, Bristol Royal Infirmary, Bristol BS2 8HW, UK

In order to ascertain the role of MRA in diagnosing peripheral vascular disease, a prospective study of all patients having peripheral angiography over a 9 month period was initiated to establish the accuracy of MRA versus duplex ultrasound and angiography. Iliac arteries and superficial femoral and popliteal arteries were duplexed by a member of the Vascular Studies Laboratory and the MRA scans and angiograms were reported independently of one another, with the MRA scans being performed within a week of the angiograms. Confidence limits were given to each examination and the overall accuracy of each examination was evaluated. MRA sequences were modified during the study to improve the quality of image, and this was reflected in the higher degree of accuracy in the scans during the latter half of the study. The various sequences performed, and the advantages and disadvantages of altering different parameters of the sequences, will be discussed. MRA is now offering a realistic, non-invasive, alternative in assessing the iliac, femoral, popliteal and distal vessels in a time-scale that is becoming more acceptable and by a method which is less operator-dependent.

10.13 – 10.21 am

Magnetic resonance angiography (MRA) of the carotid bifurcation compared with Doppler ultrasound [Paper]

[1]J M Hawnaur, [1]J M Fields, [2]R Ashleigh and [2]A Farrel

Department of Diagnostic Radiology, [1]University of Manchester and [2]University Hospital of South Manchester, Manchester M13 9PT, UK

Doppler ultrasound (US) is an accepted non-invasive method of assessing the haemodynamic significance of stenosis in patients with symptomatic carotid disease. The aim of this study was to assess the diagnostic value of MRA of the carotid vessels compared with routine vascular assessment by Doppler US. 25 patients (16 men, nine women, aged 30–79 years) with clinical features of atherosclerosis of the extracranial carotid vessels were studied. Doppler US was performed by one experienced operator, using an Ultramark 9 machine. MRA was performed independently on a 0.5 T Vectra system. 2D and/or 3D "time-of-flight" (TOF) and 3D phase contrast MRA scans were obtained of both carotid bifurcations in 22 patients (three refusals due to claustrophobia). For each investigative technique a blinded review of the findings was made, grading stenotic lesions as non-significant ($< 70\%$), significant ($> 70\%$) or as occlusion. 2D TOF MRA was found to be the most consistently useful method for imaging the extracranial and carotid vessels. There was good correlation between MRA and Doppler US for the site and severity of stenosis in nine patients with significant stenoses, and in nine patients with normal arteries or non-significant disease. In three patients, MRA overestimated the severity compared to Doppler US. These results suggest that MRA at 0.5 T may be of potential value in screening patients with atherosclerotic disease of the carotid vessels, in whom Doppler US is unsuccessful.

9.00 – 10.14 am

Techniques in Musculoskeletal Imaging

Harewood Suite I

9.00 – 9.25 am
The value of bone scans in benign disease [Invited Review]
S E M Clarke
Department of Nuclear Medicine, Guy's Hospital, London SE1 9RT, UK

Diphosphonate bone scans provide an extremely sensitive method of imaging abnormalities of bone metabolism such as trauma, infection, benign bone tumours and sites of inflammation. Both acute and chronic abnormalities of metabolism may be detected. The whole body information is obtained at a radiation dose equivalent to that of a barium enema. In addition to imaging the metabolic activity at the site of benign disease, the vascularity of the disease process may be assessed by early imaging following injection of tracer. The vascular phase of the study may be used to determine the chronicity of fractures and the inflammatory component of a metabolic process. Tomographic imaging will assist in the localization of lesions, particularly in the spine and knees. The clinical role of radionuclide bone imaging includes the assessment of the significance of X-ray abnormalities since many benign X-ray lesions such as bone islands will show no evidence of increased bone metabolism. A further use is the further investigation of patients following injury or with bone pain when the X-ray is negative. Increased diphosphonate uptake at sites of trauma or pain confirm the presence of a bone lesion such as an undetected scaphoid fractures or early acute osteomyelitis. The whole body information makes bone scanning particularly useful for detecting metabolic bone disease such as renal osteodystrophy, the localization of sites of Paget's disease, and the diagnosis of non-accidental injury in children. Radionuclide bone imaging remains a widely available, sensitive, but under utilized means of investigating patients with known or suspected benign bone disease at a moderate cost, and with an acceptable radiation dose.

9.25 – 9.50 am
Imaging of ligament injuries of the ankle and foot [Invited Review]
W W Gibbon
Department of Diagnostic Radiology, The General Infirmary at Leeds, Leeds LS1 3EX, UK

When considering ligament injuries to the ankle and/or foot six clinical questions arise, *i.e.* is there evidence of: (1) instability following acute injury; (2) chronic ligamentous injury; (3) associated injury to bone, joint capsule or tendon; and (5) pre-traumatic cause for patients' symptoms/signs, *e.g.* arthropathy. Ultrasound and MRI provide excellent soft tissue imaging but are finite resources; therefore the question arises as to how and when these modalities should be used in the investigation of such injuries. An attempt is made to provide an imaging rationale in suspected ligament injuries to the ankle and foot. The presentation will be supported by appropriate illustrations of more commonly found injuries.

9.50 – 9.54 am
A new non-invasive technique to predict the risk of neuropathic foot ulceration [Poster]
[1]J P Coffey, [2]M J Young, [1]P M Taylor and [2]J M Boulton
Departments of [1]Radiology and [2]Diabetology, University of Manchester, Manchester Royal Infirmary, Oxford Road, Manchester M13 9WL, UK

High dynamic foot pressures predict an increased risk of neuropathic foot ulceration in diabetes and may be due to reduced plantar cushioning. In order to assess the use of ultrasound as a substitute for pedobarography in centres without foot-pressure measuring systems, 26 diabetic patients' feet (half with neuropathy, four with plantar ulceration) were studied. All had dynamic foot pressures measured by pedobarography, and weight-bearing measurements of the plantar tissue beneath the metatarsal heads (MTH) by ultrasound using the new Planscan device. At each MTH, foot pressure was inversely proportional to plantar thickness, *e.g.* $r = 0.81$ at the first MTH to $r = 0.46$ at MTH3, $p < 0.01$ and $p < 0.05$ respectively. Regression

modelling of peak plantar pressures using ultrasound alone predicted up to 84.1% of the variance of plantar pressure. The close correlation between the loss of plantar tissue and increasing pressure, and the ability of ultrasound to predict plantar pressures, may, in future, allow this simple adaption of a widely available technique to substitute for pedobarography in the identification of diabetic patients at risk of ulceration.

9.54 – 10.02 am

Is a normal MRI scan in the presence of a palpable soft tissue mass enough? [Paper]

M J Thornton, C J Wakeley, S J Armstrong, I Watt and P R Goddard

Department of Clinical Radiology, Bristol Royal Infirmary, Bristol BS2 8HW, UK

The value of magnetic resonance imaging (MRI) scanning in detecting soft tissue tumours is well recognized. A retrospective search revealed a series of 23 patients, clinically diagnosed as having a soft tissue tumour or mass, in whom MRI scans were normal or showed muscle hypertrophy only. All 23 patients (11M, 12F) age range 6–66 years, (mean 34) underwent MRI scanning of the region noted to have a soft tissue mass (face, two; upper limb, six; lower limb, 13; torso, two). Prior to MRI scanning 11 had had other radiological investigations (plain radiographs seven, ultrasound three, computed tomography five, sialography one and venography one), all of which had been normal or unhelpful or suggested muscle enlargement. The signal characteristics were normal in all cases on all MRI sequences (T_1, T_2 and/or STIR). 12 scans were entirely normal, whilst 11 scans showed muscle hypertrophy (seven unilateral). All these patients remain well (mean follow-up 3.1 years). None have had surgical intervention. The excellent soft tissue contrast and high sensitivity for pathology yielded by multiple MRI sequences (in particular T_2 and STIR) make it reasonable to assume that soft tissue tumours may be confidently excluded by MRI, which would avoid unnecessary biopsies. The reason for the clinical/radiological disparity remains unclear in the majority of cases.

10.02 – 10.10 am

The comparison of CT and MR images on suspected sacroiliitis [Paper]

C Wittram, G H Whitehouse and R C Bucknall

Magnetic Resonance Research Centre, University of Liverpool, PO Box 147, Liverpool L69 3BX, UK

The clinical diagnosis of sacroiliitis can be difficult in the early stages of the disease, while plain radiographs and radionuclide images are often equivocal. CT is a sensitive method for demonstrating the changes due to sacroiliitis, but requires a large dose of radiation, and may not be accurate in assessing activity in advanced cases. A cohort of patients with sacroiliitis suspected on clinical and sometimes on radiological grounds, and a control group underwent MR scanning on a 1.5 T system. All cases were imaged in the axial plane, with T_1, T_2, T_1 with fat suppression (T_1 WFS) and short-tau inversion recovery (STIR) sequences. The sacroiliac joints of the patients were also imaged with CT. In some cases, CT and MR images were normal. In other cases CT appearances were normal but on MRI there was an increased signal on T_2 and STIR in the subarticular marrow, considered to be consistent with active inflammation. In some, but not all, cases, these subarticular changes were associated with erosions visible on CT and MR images, T_1 WFS being the most useful for this. The STIR sequences were more sensitive than T_1 WFS in demonstrating subarticular free water. In cases with clinically suspected sacroiliitis and equivocal plain radiographic findings, it is recommended that MR (T_1, T_1 WFS and STIR) be the next investigation of choice.

10.10 – 10.14 am

MRI and CT in macromelia and macrodactyly [Poster]

H F D'Costa, J P R Jenkins and P M Hughes

Department of Diagnostic Radiology, Derriford Hospital, Plymouth, PL6 8DH, and Manchester Royal Infirmary, Manchester, UK

Localized soft tissue and bone overgrowth exhibit variable distribution ranging from hemihypertrophy to macrodactyly. The conditions associated with somatic growth disturbance include chronic lymphoedema, lymphangiomatous malformations, neurofibromatosis, vascular malformations, Bannayan syndrome and Proteus syndrome. In the absence of either diagnostic dermatological manifestations or an appropriate family history, plain radiographs infrequently contribute to establishing a specific diagnosis. We report the radiographic, CT and MRI appearances in six patients presenting with either macrodactyly or macromelia. Diagnoses included macrodystrophia lipomatosa, angiolipomatosis, Klippel-Trenaunay-Weber syndrome, neurofibromatosis, blue rubber bleb naevus syndrome and one unclassified mesenchymal dysplasia. MRI of five of these patients established the nature and extent of the underlying pathological process. This provided accurate prognostic information, enabling appropriate treatment with genetic counselling. We would recommend the use of MRI for all patients with macrodactyly where the diagnosis is undetermined.

9.00 – 10.21 am

Paediatric & Antenatal Imaging

Harewood Suite II

9.00 – 9.25 am
Chest infection revisited [Invited Review]
H Carty
Department of Radiology, Royal Liverpool Children's NHS Trust, Alder Hey, Liverpool L12 2AP, UK

Chest infection in children is a common clinical problem and is a frequent reason for referral for an X-ray. All radiologists should be familiar with its interpretation, yet owing to errors of positioning, poor inspiration and lack of familiarity, it is frequently over-read and misinterpreted — especially in children with infection. The basic principles of viewing children's chest X-rays will be addressed. The indications for chest radiology in childhood chest infection, and the indications for employing other imaging procedures will be discussed. Radiographic patterns of specific infections will be discussed, including a review of the problem of tuberculosis. The aim of this review is to discuss the current role of the radiologist in imaging the problem of chest infection in children as part of the paediatric team.

9.25 – 9.33 am
Mesenteric lymphadenitis in children [Paper]
[1]C Metreweli, [2]P Sullivan and [2]S Oppenheimer
Departments of [1]Radiology and [2]Paediatrics, Prince of Wales Hospital, Chinese University of Hong Kong, Shatin, Hong Kong

The presence of massive lymphadenopathy in the mesentery in cases of tuberculosis and lymphoma is well described, but less dramatic enlargement is usually not even sought. In 30 children with recurrent abdominal pain in whom "no abnormality could be found", 50% actually had echographically demonstrable mesenteric lymphadenitis. The detection of this sign should identify that group of children in whom more intensive viral, bacterial or allergic causes should be sought.

9.33 – 9.37 am
The swollen leg and primary lymphoedema in childhood [Poster]
N B Wright and H Carty
Department of Radiology, Royal Liverpool Children's NHS Trust, Alder Hey, Liverpool L12 2AP, UK

Children who present with unilateral or bilateral swelling of the lower limbs are frequently suspected of having a deep venous thrombosis, although the incidence in childhood is low. The diagnosis of lymphoedema is seldom considered. We present three cases of primary lymphoedema occurring in childhood and a short review of the condition. Classically, the patient is an adolescent girl, who presents with spontaneous onset of painless swelling of the ankle or calf. All three cases presented diagnostic confusion because of associated limb pain, and ultimately lymphangiography was required to confirm the diagnosis.

9.37 – 9.45 am
The antenatal ultrasound diagnosis of anterior abdominal wall defects and subsequent outcome: The Northern Region experience [Paper]
E Dillon
Department of Radiology, North Tees Hospital, Stockton on Tees, Cleveland, UK

The diagnosis, management and outcome of all anterior abdominal wall defects occurring from 1988 to 1992 are studied, utilizing data from the Northern Region Fetal Abnormality Survey, which aims to register all abnormalities suspected antenatally and found postnatally, together with outcome after 1 year. 114 abdominal wall defects were notified; amnion rupture (nine), gastroschisis (57), exomphalos (45), ectopia vesicae (one) and traumatic in abortus (two). *Amnion rupture.* In eight fetuses, abdominal wall and other gross abnormalities were found: five were aborted after scan and three aborted spontaneously. *Gastroschisis.* Ultrasound failed to identify gastroschisis in 35% and incorrectly suggested exomphalos in eight fetuses. No chromosome abnormality was associated. 25% of babies required surgery following primary closure because of gut atresia, but only one postnatal death occurred, in a baby

with cystic fibrosis. *Exomphalos*. Ultrasound failed to identify this in 39% of cases. A chromosome abnormality was associated in 20% and another structural abnormality in 46%. 25% of babies died postnatally and two are alive with significant disability. There would appear to be no advantage in the routine antenatal transfer of fetuses with abdominal wall defects to the regional centre. More reliable antenatal ultrasound diagnosis is required, to allow chromosome analysis in exomphalos, and also to detect complications arising in the third trimester which do benefit from intrauterine transfer.

9.45 – 9.53 am

Fetal echogenic lung lesions [Paper]

S J King, D W Pilling and S Walkinshaw
Fetal Centre, Liverpool Maternity Hospital, Liverpool L7, UK

Fetal echogenic lung lesions may have several causes, including congenital diaphragmatic hernia (CDH), cystic adenomatoid malformation (CAM), sequestrated lung and tracheal/bronchial atresia. The purpose of this study was to evaluate the accuracy of pre-natal diagnosis and the outcome. Our unit saw 16 fetuses, aged between 17 and 36 weeks, with echogenic chest lesions seen over 5 years. We reviewed these cases retrospectively. Pre-natal diagnosis was correct in 11/16 cases with CDH (seven) and sequestrated lung (four). In 3/16, the prenatal diagnosis was undecided between CDH or CAM. Postnatally, these were found to be sequestrated lung (one) and CDH (two). Two of the 16, one diagnosed as CDH and one as tracheal atresia, have not yet been born. All babies with sequestrated lung (5/5) are well and needed no surgery. In CDH, 2/9 survived with surgery, 5/9 died soon after birth and one died *in utero*; one pregnancy was terminated. In a minority of cases, it was difficult to differentiate between CDH and CAM prenatally. However, CAM was not seen postnatally in any of these babies. We agree with recent reports of fetal sequestrated lung which described improvement *in utero* observed sonographically and better neonatal outcome than would have previously been expected. This, together with the poor outcome in fetuses with echogenic CDH, has important implications for prenatal counselling.

9.53 – 10.01 am

The value of antenatally diagnosed renal pelvic dilatation in the prediction of urinary tract pathology [Paper]

G Walsh and P A Dubbins
Radiodiagnostic Department, Derriford Hospital, Plymouth PL6 8DH, UK

Recent advances in antenatal sonography have allowed the diagnosis of a wide variety of urinary tract pathologies. Renal pelvic dilatation (RPD) has been reported as a marker for both renal disease and chromosomal abnormalities. Over a 3 year period we reviewed the antenatal demonstration of RPD with postnatal diagnoses, and compared antenatal RPD with the prediction of postnatal vesicoureteric reflux. 76 cases of RPD were detected over the 3 year period. Eight cases were lost to follow-up; of those remaining, there were 8 diagnoses of extra-renal pelves while 25 infants displayed normal pelvicaliceal systems. The remaining 35 cases demonstrated moderate severe collecting system dilatation and of these were five pelviureteric junction (PUJ) obstructions, six cases of VUR, one mega-ureter and one severely dysplastic kidney. Comparison with in-patient and out-patient records revealed 10 more infants shown to have clinically significant VUR during the 3 year period, who had no demonstrably abnormal antenatal ultrasound appearance. Antenatal screening for renal pelvic dilatation identifies a significant proportion of those who will develop urinary tract pathology in early life, but over half will not be predicted.

10.01 – 10.09 am

Accurate *in utero* fetal weight estimation using EPI [Paper]

[2]P N Baker, [2]I R Johnson, [1]P A Gowland, [1]J Hykin, [1]P R Harvey, [1]A Freeman, [1]V Adams, [3]B S Worthington and [1]P Mansfield
[1]Magnetic Resonance Centre, Department of Physics, [2]Department of Obstetrics & Gynaecology, and [3]Department of Radiology, University of Nottingham, Nottingham NG7 2UH, UK

The whole uterus and contents of 11 singleton pregnancies were scanned in the maternal transverse plane employing a multislice technique on a 0.5 T EP system. A T_2-weighted MBSST sequence was used with an acquisition matrix of 128×128, a slice thickness of 1 cm and an individual image acquisition time of 130 ms. The volume of each fetus was measured within one week of the expected delivery date by computer planimetry of multiple contiguous sections containing fetal parts. An ultrasound scan was carried out within 48 h of delivery, and assessment made of the biparietal diameter, abdominal circumference and femur length as a prelude to estimating fetal weight from Shepherd's formula [1]. A linear relationship was obtained between fetal volume and actual birthweight ($r = 0.97$), such that the mean and median difference between actual and estimated birthweight using the derived equation ($BW = 0.12 + 1.031 \times$ f. vol.) would be 3.7% and 3%, respectively. The differences between actual and estimated birthweights calculated from ultrasound parameters were significantly greater than those using EPI ($p < 0.01$). This preliminary study suggests that EPI can provide the basis for a method of accurate fetal weight estimation during gestation.

Reference
1. SHEPHERD M J ET AL, *Am. J. Obstet, Gynecol, 142*, 47 54 (1982)

10.09 – 10.17 am
Investigation of intrauterine growth retardation using EPI [Paper]

[2]P N Baker, [2]I R Johnson, [1]P A Gowland, [1]P R Harvey, [1]A Freeman, [1]J Hykin, [1]V Adams, [3]B S Worthington and [1]P Mansfield
[1]Magnetic Resonance Centre, Department of Physics, [2]Department of Obstetrics & Gynaecology, and [3]Department of Radiology, University of Nottingham, Nottingham NG7 2UH, UK

We wished to be able to identify growth retardation of the fetus from EPI-derived volume measurements of body organs and the placenta. The whole uterus and contents of 32 singleton pregnancies were scanned in the maternal transverse axial plane, supplying a multislice technique on a 0.5 T EPI system. A T_2 weighted MBEST sequence was used with an acquisition matrix of 128×128, a slice thickness of 1 cm and an individual image acquisition time of 130 ms. Following delivery, 11 of the pregnancies were shown to have been complicated by intrauterine growth retardation, using the individualized birthweight ratio. Volume estimates of the whole liver, brain and placenta were made by computer-based planimetry of multiple contiguous sections containing each organ. Measurements of fetal liver volume showed a linear relationship with gestational age in a normally growing fetus; such measurements were smaller in a growth-retarded fetus, with 10 out of 11 points falling on or outside the 95% confidence limit for normal growth. No such difference in brain or placental volumes was demonstrated between the group with normal growth and that with retarded growth. We conclude that measurement of liver volume from EP images can accurately discriminate between normal and growth-retarded fetuses.

10.17 – 10.21 am
Sonographic features of Hashimoto thyroiditis in the paediatric age group [Poster]

[1]P A K Set, [1,2]K S Oleszczuk-Raschke, [1,2]H J von Lengerke and [3,4]J Brämswig
Departments of [1]Radiology and [1]Paediatric Medicine, Addenbrooke's Hospital, Cambridge, CB2 2QQ, UK, and Departments of [2]Radiology and [4]Paediatric Medicine, Münster University Hospital, Germany

The commonest cause of goitre in childhood in the West, in areas not deficient in iodine, is Hashimoto thyroiditis. To date the accepted ultrasound (US) features of Hashimoto disease are derived from data from adult patients. We report the US findings in 17 girls and one boy with a mean age of 12 years. A total of 57 US examinations were reviewed retrospectively. The overall echogenicity of the gland (compared to the adjacent muscle) was classified into one of three groups: hyper-, iso- or hypoechogenic. The echo-poor lesions within the gland were classified according to size: fine (< 2 mm), coarse (2–5 mm) and large ($<$ 5 mm). The total glandular volume was calculated. In 58% of examinations (10 patients) the glands were hyperechoic, in 38.5% (7 patients) isoechoic and in 3.5% (1 patient) hypoechoic to muscle. In 33% of examinations a mixed pattern of echo-poor lesions was noted within the same gland. In 56% of examinations the glands were in excess of 14 ml, 25% were between 10 14 ml and 19% less than 10 ml. In patients with serial examinations, the echo texture remained unchanged despite adequate treatment. Our most common pattern of US findings, a hyperechoic or isoechoic gland with 2–5 mm echo-poor lesions throughout the organ, differs from the reported hypoechoic gland of Hashimoto disease in adults.

9.00 – 10.14 am

Radiation Protection I

Bramham Suite

9.00 – 9.25 am
Recent developments in ICRP [Invited Review]
R H Clarke
National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, UK

The Main Commission published its latest *Recommendations for Protection Against Ionizing Radiation* in 1990. The programme of work since that time has been concerned with further advice on particular areas such as the medical field and with regard to the control of exposures to natural radionuclides. The Commission has published *Advice on the Protection of Human Volunteers in Biomedical Research* and *Intervention Levels for Protection of the Public in a Radiological Emergency.* The Commission is now publishing a revised model of the human respiratory tract. This new model represents an update of the one which has been used since 1966 and estimates of dose per unit intake for a range of radionuclides in a variety of physical and chemical forms are being produced as the basis for establishing controls on intakes. The Commission has also agreed a publication on the *Control of Radon at Home and at Work* which provides a rational basis for deciding when exposure to radon at work should be classified as occupational exposure as opposed to natural background. The paper will summarize all of this work of ICRP.

9.25 – 9.33 am
The implications of ICRP 60 in GIT fluoroscopy [Paper]
A Quinn, J Upton, F Wallis, J Murphy, M Molloy and J F Malone
Department of Diagnostic Imaging, St James's Hospital, Dublin 8, Ireland

We wished to evaluate the extent to which various organs are in the field in GIT barium studies, in the light of the revised risk estimates of ICRP 60. 30 patients were studied: 20 barium meals and 10 barium enemas. All studies were performed by one of three consultant radiologists. All examinations were video-recorded with simultaneous recording of dose area product data and time. The weight, height and abdominal girth of all patients were measured. The videos were analysed by one of two radiologists. In barium meals the stomach, oesophagus and colon and liver receive significant doses which on the basis of ICRP 26 would have been insignificant. In barium enemas, the colon, stomach, bladder and liver receive doses which in the past would have been considered insignificant. We consider that, with the revised risk estimates in ICRP 60 (as compared with ICRP 26), GID fluoroscopy should be reviewed. In particular, referring physicians should be made aware of the radiation dose in GIT fluoroscopy to organs which were previously thought to be relatively radio-insensitive.

9.33 – 9.58 am
Patient protection audit in diagnostic radiology [Invited Review]
B F Wall
Medical Dosimetry Group, National Radiological Protection Board, Chilton, Didcot OX11 0RQ, UK

"Audit" implies a periodic review of a practice with a particular emphasis on financial accounting. In this paper patient protection in diagnostic radiology in the UK is audited by reviewing trends in the radiation doses delivered to patients during X-ray examinations over the past decade. Data from national surveys in the mid 1980s are compared with recent information supplied to the NRPB national patient dose database. Due to increased awareness and effort, patient protection has improved and doses from common radiographic and fluoroscopic examinations have fallen. An element of financial accounting is introduced by estimating the monetary value of the collective dose saved which may be favourably compared with the resources expanded to achieve this improvement. Local patient protection audit is advocated by encouraging X-ray departments to follow the recommendations in the *National Protocol for Patient Dose Measurements in Diagnostic Radiology.*

9.58 – 10.02 am
An assessment of staff doses in cardiac angiography [Poster]
[1]A McGee, [1]P J Gilligan, [2]D N Sugure and [1]J T Ennis
[1]The Institute of Radiological Sciences, University College Dublin, and [2]Mater Private Hospital, 52 Eccles Street, Dublin 7, Ireland

Cardiology workers in Ireland have traditionally been classified as Category B radiation workers. However, this classification is based on whole-body doses and in some cases unreliable extremity monitoring. This study aims to measure staff extremity doses in a cardiac angiography suite. Extremity and partial body doses of workers in the angiography suite of a large private hospital have been measured using thermoluminescent dosemeters. Thigh and shoulder doses measured indicate that the cardiologists need to be recategorized as Category A workers, and the other staff in the unit may remain as Category B workers. The possible risks from the radiation dose range are estimated. Methods of dose reduction are recommended.

10.02 – 10.06 am
Investigation into the routine method of assessing automatic exposure control devices [Poster]
[1]K L Smart, [2]F A F Zananiri and [1]E M Pitcher
[1]Department of Medical Physics and Bioengineering, Bristol General Hospital, Bristol BS1 6SY, and [2]Department of Medical Physics, Frenchay Hospital, Bristol BS16 1LE, UK

The inclusion of X-ray automatic exposure control devices (AECs) in commercially available X-ray units is increasing. It is subsequently important to use routinely a relevant set of quality control (QC) tests to establish and monitor various performance parameters which relate to patient dose. Although water is regarded as a realistic substitute for soft tissue, it is rather impractical for routine QC testing of AECs. Copper is therefore more frequently used as an equivalent patient (HPA Topic Group Report 32, Part IV). The aim of this work is to ascertain whether the measurement of exit dose from copper or water is a satisfactory means of verifying the performance of X-ray AECs, rather than measuring film optical density which is more expensive and time-consuming. The method involved measuring the exit doses and associated film optical density for various materials (copper, water, Perspex) of varying thicknesses over the diagnostic energy range of 60 kVp to 120 kVp. Investigations show that the method of assessing AECs by the use of copper or water and measuring exit dose only is not a satisfactory method; for both materials the film optical density must be measured. Results show large variations in measured exit dose across the range of kVs and thicknesses despite the optical density variation of the films remaining within $\pm 10\%$. This is attributed to the AEC system being "tuned" to a particular film/screen combination as the rare-earth phosphors used have different characteristic k-edges.

10.06 – 10.10 am
Radiation dose and image quality in two chest radiography techniques [Poster]
D J Manning, A Cooper and N Rogers
Department of Radiography, King's College London, London SE5 9RS, UK

The study compares two chest radiography techniques with respect to radiation dose and image quality, with a view to correlating physical measurements and observer grading. 46 chest radiographs were examined; 24 were produced using a radiation grid, and 22 using an air gap. Measurements of system resolution and radiation dose were carried out. Processor and film/screen combinations were compared, and measurements of optical density were made at three points in each image. Observers were asked to score the films using a grading system. The techniques showed comparable resolution, contrast and optical density values. The air gap system was faster, and resulted in a radiation dose saving. There were no separable differences in image quality between the observer scores. Some of the assessment criteria correlated with some of the measurements of optical density and contrast, but not all criteria. An air gap method of PA chest radiography using a faster image-recording system produces equally high-quality images with a dose to the patient considerably less than in a grid technique. Image quality criteria as scored by experienced observers correlate with certain measurable parameters in the images.

10.10 – 10.14 am
A comparison of operator dependent factors in barium meals when using conventional radiography versus 100 mm photofluorography [Poster]
A S K Dzik-Jurasz and N W Garvie
Medical Imaging Department, Royal London Hospital, London E1 1BB, UK

It is generally assumed that the dose savings made by using 100 mm photofluorography outweigh the superior imaging characteristics of conventional radiography in upper gastrointestinal studies. A retrospective study of our Diamentor readings, screening times, number of films taken and radiologist grade was made to determine whether there was a difference in relation to the two differing imaging modalities. The records over a 6 month period (May–

October 1993) of the Diamentor readings (PTW-Diamentor-D), screening times, number of films taken during barium meal examination as well as the grade of radiologist, using an overhead Siemens Siregraph B.150 with Sircam-106 photofluorography and DuPont-UV Rapid screens with DuPont Ultravision-G film, were compared. A *t*-test was used to determine significance. There was no significant difference in Diamentor reading or screening time when comparing the two methods. There was however a significant difference between the two methods in the number of images taken. Mean for conventional radiography was 8.2, whilst the mean for 100 mm photofluorography was 18. A significant difference existed between the most junior radiologists and all other grades in terms of Diamentor readings and screening times. We could not show any advantage in dose saving by using 100 mm photofluorography rather than conventional radiography. Screening times are similar, but significantly more films are taken using 100 mm photofluorography. Teaching establishments should take into account the significantly greater dose incurred by patients from junior training-grade radiologists.

9.00 am – 12.00 noon

Symposium: Molecular Genetics and Cancer Biology

Charter Suite

The induction of genetic instability by ionizing radiation [Invited Review]

E G Wright
Division of Radiobiological Mechanisms, MRC Radiobiology Unit, Chilton, Didcot, Oxon OX11 0RD, UK

Exposure to ionizing radiation produces a number of biological consequences including gene mutation, chromosome aberrations, cellular transformation and cell death. These effects are attributed to the DNA-damaging effects of the irradiation resulting in irreversible changes during DNA replication or during processing of the DNA damage by enzymatic repair processes. Accordingly, it has been widely accepted that most of these changes take place in the cell cycles immediately following exposure. It has been apparent for many years, however, that expression of cytotoxicity may be delayed for several generations of cell replication with death occurring randomly among the progeny cells. This phenomenon of delayed reproductive death has been attributed to the induction of "lethal mutations" arising in the descendants of cells surviving irradiation. More recently, evidence has been accumulating that cells initially surviving radiation and capable of proliferation may produce descendants that express chromosome aberrations and gene mutations; *i.e.* ionizing radiation may induce a transmissible genetic instability producing a variety of cellular effects detected after many cell cycles in the progeny of the irradiated cells. The nature of these effects appears to be influenced by qualitative and quantitative aspects of the radiation exposure, cell type and genetic characteristics of the irradiated cell but the molecular basis of radiation-induced genetic instability is not yet understood.

Clinical and molecular genetics of breast and ovarian cancer [Invited Review]

B A J Ponder
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About 40% of families with multiple cases of breast cancer, and a high proportion of families with both breast and ovarian cancer, appear to have developed their cancer as a result of mutation in a predisposing gene BRCA1 on chromosome 17. Women at risk in the multiple case families can be offered counselling about their risks, screening by mammography and ovarian ultrasound, and possibly prophylactic surgery (oophorectomy, mastectomy). The effectiveness and acceptability of these have yet to be fully evaluated. In the future, therapeutic modification of risk (*e.g.* by endocrine manipulation) may be possible. DNA testing may indicate whether or not an individual has inherited the predisposing gene. It is not yet known how many individuals will want to have this information, and what the effects may be. It does seem clear, however, that these "high risk" individuals who are recognizable by their family history will account for only a small proportion of breast or ovarian cancer. In the future, it will be important to determine whether there is also significant inherited predisposition outside the uncommon multiple-case families. In principle, a contribution from low-level predisposition by one or more common genes is also possible, and such predisposition might be significant in a much higher proportion of these cancers, with important implications for cancer control. This question must be addressed by testing for mutations or altered distribution of polymorphisms in candidate genes in large population-based series of cancer cases and controls.

The p53 suppressor gene [Invited Review]

D P Lane
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The human gene for p53 is located on chromosome 17p and encodes a 393 amino acid nuclear phosphoprotein. Somatic point mutation of this gene is found at high frequency in most human cancers. In mice, knockout of p53 function permits normal development but confers an enormously elevated risk of developing neoplasia. Many of the point mutations in p53 found in human cancer are associated with accumulation of the protein and alteration of its conformation making it an attractive target for novel diagnostic and therapeutic approaches. Treatment of cells with a range of genotoxic agents stabilizes the normal p53 protein and this may explain the growth arrest induced by these agents. Our current model suggests that p53 is a "guardian of the genome" acting to protect cells from genetic damage by inducing a specific cell cycle arrest or apoptosis. Recent studies in the p53 defective mice show that p53 is essential for the normal apoptotic response of thymocytes and intestinal epithelial cells to ionizing radiation. The genetic instability resulting from inactivation of this pathway is a key step in neoplasia as it permits the rapid evolution of genetic variants. We are attempting to define other gene products involved in the p53 response to DNA damage and examine their role in neoplasia.

Radiation oncogenesis — mechanisms and genetics [Invited Review]

R Cox
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The resolution of the mechanisms and genetics of radiation oncogenesis represents a major task in radiation research. Research outside the field of radiation biology is beginning to resolve many of the fundamental aspects of the carcinogenic process but it is critically important to be able to relate these advances to the effects of ionizing radiation on the genomes of human somatic cells. This brief review considers current knowledge on the gene and chromosomal mutations that mediate oncogenesis and the implications for molecular and biophysical modelling of radiation effects relating to cancer risk. Comment will also be made on the possible application of knowledge on the mechanisms and genetics of cancer in the determination of tumour causality and for future judgements on individual cancer risk.

10.45 am – 12.02 pm

Oncology Imaging II

Royal Hall

10.45 – 11.10 am
Staging renal cell carcinoma — update 1994 [Invited Review]
B L McClennan
Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis, Missouri 63110, USA

Significant progress has been made in the last decade using cross-sectional imaging techniques to diagnose and stage renal cancers. The evaluation of patients with real or suspected renal cell carcinoma has changed with a greater emphasis on computed tomography (CT) and increasing reliance on magnetic resonance imaging (MRI) and ultrasound, especially colour Doppler (CDU), as problem solving methods. Many renal cancers are still diagnosed by serendipity, in the presence of vague signs or symptoms. Recent trends indicate an increasing frequency in younger individuals especially females, even adolescents. Further, given the ubiquitous nature of cross-sectional imaging studies, *e.g.* CT and ultrasound, renal cell carcinomas are increasingly encountered at a small or very small size, *i.e.* less than or equal to 3 cm. This may lead to improved prognosis and disease free survival (stage migration) if treated promptly. This trend has sparked a resurgence of interest in screening for renal cancer and in new surgical techniques for treatment, *e.g.* segmental, partial nephrectomy and laparoscopic nephrectomy. CT remains the optimal cross-sectional imaging technique for staging renal cell carcinoma, especially now that spiral (helical) CT is available. Fast, accurate, contrast enhanced renal CT using spiral techniques satisfies the criteria for accuracy and can improve diagnostic certainty regarding organ of origin and attenuation values. When contrast enhancement is not clinically feasible, MRI may accurately stage renal cell carcinoma. Small cancers and those with unusual internal features, *i.e.* calcification, may be difficult to accurately discern with MR. Colour Doppler ultrasound may be helpful in problematic or indeterminate cases. When biopsy is required, CT will provide an optimal approach for cytopathologic or histopathologic needle biopsy. For assessment of regional or distant metastatic disease and for patient imaging follow-up, CT remains the current best technique.

11.10 – 11.18 am
CT criteria for partial nephrectomy in Wilms' tumour following pre-operative chemotherapy [Paper]
C M Owens, P S Babyn, M Greenberg, P Thorner and G McLorie
Department of Diagnostic Imaging, The Hospital for Sick Children, Toronto, Ontario M5G 1X8, Canada

With the improved survival of patients with Wilms' tumour, our current treatment protocol is now focused on minimizing toxicity and preserving renal tissue. Initial evaluation (CT and US) is followed by percutaneous biopsy, preoperative chemotherapy and repeat imaging. We assessed the accuracy of radiological staging by correlation with pathological and surgical material in an attempt to define criteria allowing partial nephrectomy. Radiological studies in 42 consecutive patients with Wilms' tumour (eight bilateral, 33 unilateral and one horseshoe) were retrospectively reviewed for changes in tumour size, extent and attenuation. Significant downgrading was evident on CT with mean tumour shrinkage of 77%, reduction in pulmonary metastases, lymphadenopathy and intravascular tumour thrombus. 11/42 patients (six bilateral, four unilateral, one horseshoe kidney) were suitable for partial nephrectomy with lack of collecting system or vascular invasion and residual tumour confined to the upper or lower renal poles, completely excisable by wedge resection along with surgical confirmation of satisfactory residual arterial supply. Survival is 87% (follow-up 6–68 months, mean 24 months). Two patients have relapsed with tumour adjacent to the renal remnant, necessitating further surgery. Radiological staging accurately assesses Wilms' tumour, allowing consideration of partial nephrectomy.

11.18 – 11.26 am

Work in progress: staging of cervical carcinoma by high field MRI with endorectal surface coil [Paper]

K W Preidler, F Ebner, D Szolar and G Ranner
Magnetic Resonance Section, Department of Radiology, Karl Franzens University and Medical School, A-8036 Graz, Austria

We compared MR images obtained with endorectal surface coil (endo-MRI) and with body coil in the assessment of tumour staging of cervical carcinoma. In 10 patients with biopsy-protein cervical carcinoma (FIGO Ib and IIb), MRI (1.5 Tesla, Gyroscan ACS, Philips, Netherlands) was performed with endorectal surface coil (Philips) as well as body coil. We used axial and sagittal T_2 weighted spin echo and turbospin echo sequences. Slice thickness was 3 mm, FOV 120 mm (surface coil) and 300 mm (body coil); acquisition matrix 256 × 256. All pathology specimens were worked up with giant histology sections. Endo-MRI shows accurate anatomical details of cervix, vagina and perirectal tissue and is able reliably to depict parametrial infiltration. Endo-MRI seems to be considerably more accurate in the assessment of minimal parametrial infiltration than MRI with body coil. Furthermore, turbo spin echo sequences in Endo-MRI enable local lymph node staging. Tumour staging in cervical carcinoma is essential for therapy, and MRI with endorectal surface coil improves delineation of anatomical details and is more accurate than MRI with body coil in tumour staging of cervical carcinoma.

11.26 – 11.30 am

Patterns of supradiaphragmatic metastatic disease in patients with testicular germ cell tumours [Poster]

[1]A Wood, [1]N Robson, [1]K Tung and [2]G Mead
Departments of [1]Radiology and [2]Oncology, Royal South Hants Hospital, Southampton SO9 4PE, UK

In order to determine the patterns of supradiaphragmatic metastatic spread in patients with testicular germ cell tumours, 33 patients (11 seminomas and 22 teratomas) with supradiaphragmatic disease were reviewed retrospectively (four had recurrent disease, the rest were initial presentations). All had chest radiographs (CXR): 29 had chest CT scans. One seminoma patient had lung metastases on CT, not visible on CXR. 10/22 teratoma patients had lung metastases on CT, 9/22 on CXR. Mediastinal disease was present in 7/11 seminomas on CT and 6/11 on CXR, and 9/22 teratomas on CT and 6/22 on CXR. CT detected disease in paravertebral and subcarinal lymph nodes more accurately than CXR. The most commonly involved lymph nodes were paravertebral (American Thoracic Society Groups 8R and 8L) in seminoma, and subcarinal (Group 7) in teratoma. Neck lymphadenopathy (mainly left-sided) was present in 10/11 seminomas and 13/22 teratomas. Neck disease coexisted with mediastinal disease in 6/11 seminomas, but only 2/22 teratomas. All patients had abdominal lymphadenopathy except the four patients who had received prior radiotherapy. None had liver metastasis. In seminoma, disease appeared to spread in near-contiguous fashion from the abdomen through the mediastinum to the neck. This pattern was rare in teratoma, confirming that haematogenous spread is more important.

11.30 – 11.38 am

High field MRI of early prostatic cancer with an endorectal surface coil: pathological correlation on step serial giant sections after radical prostatectomy [Paper]

K Preidler, G Ranner, M Ratschek, M Rauchenwald, D Szolar and F Ebner
Department of Radiology, MR Section, Karl Franzens University and Medical School, A-8036 Graz, Auenbruggerplatz 9, Austria

We compared the MR images obtained with an endorectal surface coil in patients with prostatic cancer, Stages A–C, with the histopathological findings after radical prostatectomy. In 15 patients with biopsy-proven prostatic cancer who subsequently underwent radical prosotatectomy, MRI with an endorectal surface coil was performed. The studies were done on a 1.5 Tesla unit with T_1-weighted transversal and T_2-weighted transversal and coronal spin-echo sequences (slice thickness: 3 mm, FOV: 120 mm). All pathology specimens were worked up with giant histology sections. The MR images and the histology results were compared with special respect to involvement of: (a) the prostatic capsule, (b) the periprostatic tissue (neurovascular bundle) and (c) the seminal vesicles. MRI was able to reliably depict infiltration of the periprostatic tissue to an extent of more than 5 mm. MRI did not show minimal invasion of the prostatic capsule (so called "minimal stage C") and failed to show microscopic invasion (less than 5 mm) of the periprostatic tissue in 8/15 patients. In the remaining patients MRI was true negative. Infiltration of the seminal vesicles was true positive in 4/15 cases; in two patients MRI was false positive; in one patient false negative. Pre-operative determination of prostatic cancer stage is essential for therapy. Endorectal coil MRI of the prostate is highly accurate in depicting major periprostatic infiltration, but seems to be considerably less accurate in assessment of infiltration of the seminal vesicles.

11.38 – 11.46 am

Transrectal ultrasound in follow-up of patients receiving radical radiotherapy for prostate cancer [Paper]

[1]A M Watson, [2]D R Harriss, [1]P J McMillan, [2]M C Bishop and [3]I D Ansell

Departments of [1]Radiology, [2]Urology and [3]Histopathology, City Hospital NHS Trust, Nottingham NG5 1PB, UK

This study compares the efficacy of transrectal ultrasound of the prostate (TRUS) and rectal biopsy with prostatic specific antigen (PSA) estimation in the diagnosis of recurrent prostatic carcinoma. Over a 10 year period (1982–1991) 41 patients with localized carcinoma of the prostate were treated with radical radiotherapy. Of these, 25 were clinically in remission and were invited to attend for PSA estimation, TRUS and ultrasound-guided biopsy. Patients were classified into four groups according to PSA value, sonographic appearance and histology: (1) PSA raised; TRUS malignant; histology malignant (10 patients, 40%). These have relapsed locally. (2) PSA normal; TRUS benign; histology benign (seven patients, 28%). This group is in remission. (3) PSA raised; TRUS benign; histology benign (two patients, 8%). These patients either have distant metastases or are false positives for PSA. (4) PSA normal; TRUS malignant; histology malignant (six patients). These are false negatives for PSA. The possibility that these tumours had de-differentiated following radical radiotherapy and were failing to express PSA was discounted, as all six patients' samples were positive for PSA on histological staining. We concluded that PSA is not as sensitive at detecting local relapse in prostatic cancer after radiotherapy as has been claimed previously. TRUS of the prostate is very effective in evaluating the irradiated prostate. Radiotherapy is not achieving the goal of completely treating carcinoma of the prostate: 29 of the original group of 40 patients have definite evidence of relapse.

11.46 – 11.54 am

CT evaluation of treatment response in gastric cancer [Paper]

[1]V W K Ng, [1]V Nicolson, [1]I Minty, [2]D Cunningham and [1]J E Husband

[1]Department of Diagnostic Radiology and [2]GI Unit, Royal Marsden Hospital, Sutton, Surrey SM2 5PT, UK

We documented the CT patterns of chemotherapeutic response in Phase II of our study of gastric cancer. 90 patients treated with multi-agent chemotherapy for gastric cancer were evaluated. CT was performed prior to treatment and then after 3, 6 and 8 cycles of chemotherapy. Serial measurements of the primary tumour and metastases were made. 45 patients showed tumour regression at the primary site and 80 showed regression of metastases, which were documented in the liver (35%) and regional lymph nodes (50%). Other sites included adrenals, lungs and peritoneum. The primary tumour completely resolved on CT in four patients, showed 50% regression in 30, and 50% in 40 (25 tumours were not measurable due to various factors which will be discussed). Regional lymph nodes completely resolved on CT in 15, and showed 50% regression in 20, 50% in 11. Complete regression of liver metastases was seen in four, 50% in 17 and 50% in 16. In other sites, no definite pattern of regression was revealed. CT plays a vital role in assessment of response of chemosensitive gastric cancers. This study demonstrates the patterns of regression of primary and metastatic sites. The advantages and limitations of CT are discussed.

11.54 am – 12.02 pm

The role of computed tomography in the management of patients with cutaneous T-cell lymphoma [Paper]

[1]D C Howlett, [1]W L Wong, [2]N P Smith and [1]A B Ayers

[1]Department of Radiology and [2]St John's Institute of Dermatology, St Thomas' Hospital, London SE1 7EH, UK

In patients with cutaneous T-cell lymphoma (CTCL) accurate assessment of nodal and extra-nodal disease is important as it influences prognosis and treatment plan. The aim of our retrospective study was to evaluate the role of computed tomography (CT) in the management of patients with CTCL. 28 patients with histologically proven CTCL underwent CT scanning (classical mycosis fungoides, 15; Sezary's syndrome, six; other forms of CTCL, seven). A total of 40 scans were reviewed. CT scans included those of the head and neck, chest, abdomen, pelvis or some combination of these. We considered nodes abnormal if there were (a) multiple mediastinal, hilar, retrocrural, abdominal or pelvic nodes larger than 1 cm; (b) multiple axillary or inguinal nodes greater than 1.5 cm. Scans were classified as inderminate if there were increased numbers of normal sized nodes. 12 CT scans were normal, 13 abnormal and 15 indeterminate. CT imaging demonstrated systemic nodal or organ involvement in eight of the 13 abnormal scans. Abnormal findings included hepatomegaly (one), splenomegaly (three), pulmonary nodules (two), significant adenopathy (eight), chest wall lesions (two), liver (one) and vertebral deposits (one). Clinical management was altered as a result of the scans in six patients with mycosis fungoides, five with Sezary's syndrome and three with other subtypes of CTCL. We conclude that CT scanning should be included in the evaluation of patients with CTCL, as it can provide important information which may alter the plan of treatment.

10.45 am – 12.06 pm

Interventional Radiology

Ripley Suite

10.45 – 11.10 am

Interventional radiology in the management of benign biliary strictures [Invited Review]

A Adam

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Benign biliary strictures are usually iatrogenic. The frequency of bile duct damage has increased significantly since the introduction of laparoscopic cholecystectomy. In most patients surgical repair achieves satisfactory results with a relatively low complication rate. However, there are many patients in whom complicating factors such as multiple previous operations, portal hypertension, cirrhosis of the liver and other conditions make surgery hazardous and decrease its success rate. In such cases interventional radiology can make a significant contribution to clinical management. Percutaneous transhepatic balloon dilatation is effective in the majority of patients. However, there is a significant rate of re-stenosis and in patients in whom multiple recurrences occur it is best to employ a retrograde approach via a subcutaneously-fixed Roux loop which is marked with radioopaque markers to facilitate puncture under fluoroscopic guidance. In a small number of patients with recurrent benign strictures for which there is no alternative treatment it is justifiable to use self-expandable metallic endoprostheses: preliminary results suggest that these stents are effective in dilating very resistant strictures and can successfully prevent re-stenosis.

11.10 – 11.18 am

Expandable metal stents in patients with benign biliary disease [Paper]

P Sanville and D F Martin

Department of Radiology, Withington Hospital, Manchester M20 8LR, UK

The use of metal stents in benign biliary disease is contentious. We have used Wall stents in the management of gallstones where endoscopic access was impossible due to gastric surgery or biliary stricture, in four men and three women, mean age 74 years. Three patients, with sclerosing cholangitis, had multiple stones above a common duct stricture. Two, with polya gastrectomy, had percutaneous stent insertion for multiple large common duct stones after ERCP had failed. One patient with a stone above a common duct obstruction caused by a pancreatic abscess was treated percutaneously. One patient had a large concretion around a retained stent fragment above a tight common duct stricture. Wall stents were placed successfully across common duct strictures in five patients and across the papilla in two. All stones were cleared through the stents. There has been no complication. The Wall stent is helpful in selected elderly patients with benign biliary disease when stones are retained above a stricture or an endoscopically inaccessible papilla.

11.18 – 11.22 am

Significance and management of coincidental calculi found distal to duct tumours at percutaneous biliary stenting [Poster]

D M Nichols

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Six out of 36 patients with malignant lesions obstructing their common hepatic duct or hilum were found at percutaneous transhepatic biliary stent insertion to have coincidental non-obstructing calculi present within their distal common bile ducts. Of these six patients, five had cholangiocarcinoma and one had carcinoma of the gallbladder. In two cases the stones impacted distally in the common bile duct and caused obstruction to the drainage from the stent. There is no recognized causative relationship between common duct stones and the development of cholangiocarcinoma, and these stones were found to be soft and easily crushed, having probably been formed as a result of stasis. Techniques of managing these patients are discussed.

11.22 – 11.30 am

The role of percutaneous cholecystolithotomy in the era of laparoscopic cholecystectomy [Paper]

R A Morgan, E Wallser, G R Wittich and E van Sonnenberg

Department of Interventional Radiology, University of Texas Medical Branch, Galveston, Texas, USA

The success of laparoscopic cholecystectomy has reduced the need for percutaneous radiological treatment of cholecystolithiasis. We present our experience with percutaneous cholecystolithotomy in 17 patients treated over the past three years, *i.e.* since laparascopic cholecystectomy became available at our institution. Our series includes 12 high-risk patients with acute calculous cholecystitis. Five patients with symptomatic gallstones refused general anaesthesia and therefore underwent elective percutaneous treatment. Lateral transhepatic cholecystostomy was performed under sonographic/fluoroscopic or CT/fluoroscopic guidance. Tracts were dilated to 18F. Percutaneous cholecystostomy was successful in all patients. ESWL was used for stone fragmentation in two patients, electrohydraulic lithotripsy in three patients, and mechanical lithotripsy in three patients. In the remaining patients with stones smaller than 7 mm, fragmentation was not required. Elective cholecystectomy was performed in two patients after successful control of acute cholecystitis. Percutaneous cholecystolithotomy resulted in complete gallbladder clearance in the remaining 15 patients. There were two haemorrhagic complications. Percutaneous cholecystostomy remains an effective alternative to cholecystectomy for high-risk patients with acute calculous cholecystitis. It can be followed by percutaneous stone removal or may allow subsequent elective cholecystectomy. Elective cholecystolithotomy may be offered to selected patients with symptomatic stones who refuse surgery.

11.30 – 11.38 am

Drainage of the postoperative left subphrenic abscess: is a transpleural approach contra-indicated? [Paper]

M M J McNicholas, M J Lee, J Echeverri, G W Boland and P R Mueller

Department of Radiology, Massachusetts General Hospital, Boston, MA 02114, USA

We reviewed the charts of 25 patients who underwent a left subphrenic abscess drainage to analyse whether there was an increase in complications related to this approach. We also reviewed the aetiology, technique and results of drainage in these patients. 24/25 patients with left subphrenic abscess had a recent splenectomy; seven had partial pancreatectomies. 20 patients were drained using CT guidance. Five were drained with a combination of ultrasound and fluoroscopy. Catheters varied in size from 12 to 16 French; 16 patients had size 12 French. Amylase was obtained in the fluid in 13 patients. A transpleural approach was used in 80% of cases. Four patients had complications associated with this approach, which resulted in the placement of chest tubes in two. No patient had a secondary infection or empyema; six patients had elevated amylase in the fluid that was aspirated from the left upper quadrant, indicating a pancreatic injury as the cause of the abscess. 90% patients had successful percutaneous catheter drainage. Drainage time varied between 2 and 4 weeks, and was shorter in patients who did not have an elevated amylase in their subphrenic fluid. This study confirms that a transpleural approach is both safe and successful. Interventional radiologists should obtain an amylase on all specimens from postoperative left upper quadrant abscesses.

11.38 – 11.46 am

Pancreatic necrosis: role of percutaneous drainage [Paper]

R A Morgan, E Wallser, G R Wittich and E van Sonnenberg

Department of Interventional Radiology, University of Texas Medical Branch, Galveston, Texas, USA

Pancreatic necrosis is a severe complication of acute pancreatitis. It may require intervention secondary to infection and sepsis, to development of massive fluid collections or to systemic effects including multi-organ failure. CT-guided needle aspiration and catheter drainage were performed in 17 patients. Catheter size ranged from 12 to 24F. Patient care included vigorous irrigation, frequent tube checks and follow-up with contrast-enhanced CT scans. Ten patients presented with infected and seven with non-infected collections. Eight patients (47%) were cured with a mean duration of catheter drainage of 3.8 weeks. A beneficial temporizing effect was achieved in five patients (29%); these underwent delayed surgery. Early surgery was required in four patients (24%) due to failure (two) or haemorrhagic complications (two). In addition to the accepted role of diagnostic needle aspiration, percutaneous catheter drainage seems to be curative in almost half of the patients with severe necrotizing pancreatitis and to have a beneficial temporizing effect in almost one-third of patients.

11.46 – 11.50 am

Thoracic complications of intercostal percutaneous nephrolithotomy [Poster]

J Richenberg, D Rickards, Z Amin and M J Kellett

Department of Radiology, Middlesex Hospital, Mortimer Street, London W1N 8AA, UK

Three cases of serious thoracic complications following intercostal percutaneous nephrolithotomy (PCNL) are

reported. Upper pole caliceal stones (one left kidney, one right) and a left upper pole caliceal diverticular stone were successfully removed by puncture above the 12th rib. Adequate nephrostomy tubes were not placed post-operatively. Following PCNL, hydrothoraces occurred in two patients and a hydropneumothorax in the third. One patient required thoracotomy because recognition of the complication was delayed and the pleural fluid became loculated. The other two patients responded to intercostal chest drainage, although in one of these patients, it was not noticed that the nephrostomy tube had migrated across the diaphragm into the pleural space, which delayed the removal of the chest drain. Chest complications can be expected in 3% of intercostal punctures for stone removal. Early recognition is vital and all patients should have an immediate post-operative expiration chest X-ray. Nephrostomy drainage is also recommended.

11.50 – 11.58 am
Ureteric stricture disease — A new treatment with permanent metal stents [Paper]
D Rickards
Department of Radiology, The Middlesex Hospital, London W1N 8AA, UK

Ureteric strictures are definitively treated by open surgery. Less invasive therapies include the use of double J stents, balloon dilatation and stenting, laser ablation and dilatation with ureteric dilators. Recurrence with these less invasive procedures can be expected in 75% of cases. Permanent metal stents have already proven their use in the prostatic urethra for outflow obstruction and in the bulbar urethra for urethral stricture disease. Such stents have rarely been used in the ureter because of experimental work that showed considerable epithelial hyperplasia that blocked the stent. This paper discusses the results of the implantation of 14 stents into five ureters. All patients had varying lengths of ureteric strictures as a result of malignant disease treated by radiotherapy. It was thought that the avascular nature of such strictures would result in no epithelial overgrowth. 6 mm diameter stents were placed across the strictures, using an antegrade approach after balloon dilatation of the stricture. At 6 months, all ureters were patent on follow-up excretory urography with no evidence of recurrent stricture of epithelial hyperplasia blocking the stent. The use of metal stents should be considered in those cases with post-radiotherapy strictures.

11.58 am – 12.06 pm
Metal stents for treatment of benign ureteral strictures: mid-term follow-up [Paper]
R A Morgan, E Wallser, G R Wittich and E van Sonnenberg
Department of Interventional Radiology, University of Texas Medical Branch, Galveston, Texas, USA

Insertion of expandable metal stents is a promising new technique for the treatment of benign ureteral strictures. We present the technique and results, including mid-term follow-up, in nine patients. Selection criteria included the presence of benign ureteral or uretero-enteric strictures and failure to respond to balloon dilatation as determined by manometery. Wallstents were inserted under fluoroscopic guidance in five patients and under combined endoscopic/fluoroscopic control in three patients. Patients were followed clinically and with radiograph imaging techniques (IVU, ultrasound, loopogram). Placement of metal stents was technically successful in all patients. Eight are alive and asymptomatic (follow-up 4–26 months (mean 14 months)). Re-intervention was required in one patient for partial stent blockage. One patient died within two months from unrelated disorders. Treatment of benign ureteral strictures with metal stents is safe and effective. Due to the low re-intervention rate, this technique may be more cost-effective than management with plastic tubes.

10.45 am – 12.06 pm

Musculoskeletal Imaging

Harewood Suite I

10.45 – 11.10 am
Magnetic resonance of synovial disease [Invited Review]
V Jevtic, I Watt, B Rozman, O Jarh and F Demšar
Institute for Radiology, University Clinical Center, 61000 Ljubljana, Slovenia

Conventional radiological investigations, as well as clinical examinations, are not able to demonstrate active inflammatory synovial proliferation in rheumatoid arthritis (RA) and seronegative spondylarthritis (SSA) reliably. However, this feature is a vital indicator of disease activity. Erosive osteoarthritis (EOA) has an inflammatory synovial component as well. This study was undertaken with the purpose of trying to investigate the value of contrast medium enhanced MRI in evaluating active inflammatory synovial proliferation, its therapeutical response to non-steroid antirheumatic drug in RA, and to demonstrate both similarities and differences between the intraarticular and extraarticular findings in RA, SSA and EOA. 65 hand joints in patients with RA, 26 with SSA and 19 with EOA were examined by conventional radiography and MRI. MRI was performed on a Bruker Biospec System with 2.35 T magnet and small bore diameter of 22.5 cm. The FOV was 12 cm with a data acquisition matrix of 256^2. A SE sequence with T_1W (603/30 ms) and T_2W (2045/90 ms) images was used, followed by T_1W post-contrast examination (Gd-DTPA 0.1 mmol/kg $^{-1}$ bw). In patients with RA all the examinations were repeated after 6 months of therapy. The patients with EOA and six patients with SSA also had GE images (205/10/30°). MRI demonstrated signs compatible with active inflammatory disease in 91% of patients with RA, 76% with SSA and 63% with EOA. Changes in MRI appearances of synovial proliferation could be registered in 45% of patients with RA after 6 months of therapy. It is concluded that Gd-DTPA-enhanced T_1W and T_2W images provide information which is presumably compatible with active inflammatory synovial proliferation. No definite conclusion on the value of MRI in the evaluation of therapeutic response could be drawn. MRI is capable of providing specific differential diagnosis between RA and SSA, which may be of clinical importance in early diagnosis and management of patients whose arthritis is unclassifiable.

11.10 – 11.14 am
Enlarged iliopsoas bursae in the presence of a normal hip radiograph: imaging of seven cases [Poster]
F L Flanagan, R Coughlan and D O'Connell
Department of Radiology, University College of Dublin, Institute of Radiological Sciences, Mater Misericordiae Hospital, 52 Eccles Street, Dublin 7, Ireland

Most of the literature to date refers to iliopsoas bursitis in the presence of an abnormal hip joint on the plain radiograph. We present seven cases of enlarged iliopsoas bursae when the hip radiograph was normal. Patients presented with symptoms of hip pain and limited mobility. Plain radiographs were normal. All patients had a hip arthrogram performed, which demonstrated an enlarged iliopsoas bursa; the articular cartilage and hip joint space were normal. A communication with the hip joint was demonstrated in only one case — a case of septic arthritis. Two patients had an associated groin mass, one of which produced local pressure symptoms and retroperitoneal extension. Where a mass was palpable, ultrasound and CT scans were performed. While one case subsequently had septic arthritis diagnosed by synovial biopsy, and two cases had a past history of rheumatoid arthritis, the remaining four cases were isolated findings in the absence of any recognized hip pathology. In all cases the enlarged bursa was demonstrated by an arthrogram. We conclude that in the presence of persistent hip pain or reduced range of movement, iliopsoas bursitis should be considered as a potential diagnosis, even in cases where the plain hip radiograph is normal.

11.14 – 11.18 am
MRI of the femoral intercondylar notch width index [Poster]
[1]J C Hacking, [1]R Mackenzie, [2]D J Dandy and [1]A K Dixon
Departments of [1]Radiology and [2]Orthopaedics, Addenbrooke's Hospital and the University of Cambridge, Cambridge CB2 2QQ, UK

A narrow femoral intercondylar notch has been implicated as a risk factor for anterior cruciate ligament (ACL) tears.

Although measurements of the notch width index (NWI) have been reported for plain radiography and CT, there are few MRI reports on this topic. It was our purpose to develop the assessment of notch stenosis on MRI examinations and to further investigate the association of notch stenosis with ACL tears. From our MRI records, 25 patients with arthroscopically proven torn (11 patients) and normal (14) ACLs were identified. Measurement of the NWI was made on the coronal MR image which demonstrated the popliteus tendon insertion. The narrowest intercondylar distance was divided by the femoral width at the popliteus insertion. A NWI of less than 20% has been regarded as evidence of stenosis. Four of the 25 patients had notch stenosis; these four all had ACL tears ($p < 0.03$, Fisher's exact test). This study shows that the assessment of the Notch Width Index can be made from a standard MRI examination and confirms the association with ACL tears. Notch stenosis (and associated osteophytes) should be assessed in patients with ACL tears. Knowledge of notch capacity should also be of interest to athletes in high-risk sports.

TUESDAY

11.18 – 11.26 am

Transcutaneous electric nerve stimulation (TENS) during distension shoulder arthrography: a controlled trial [Paper]

B Morgan, A R Jones, K Mulcahy and D B Finlay
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Transcutaneous electric nerve stimulation (TENS) is a safe and simple form of analgesia showing beneficial results in many painful conditions, although little use during routine procedures. Distension shoulder arthrography for "frozen shoulder" has been found to be an effective therapeutic procedure and is recognized as painful. This trial investigates the use of TENS in the radiology department, using distension shoulder arthrography as a model. 60 patients with a clinical diagnosis of frozen shoulder were randomized to receive high intensity TENS (maximum therapeutic level), low intensity TENS or to act as controls. A standard procedure was performed by one of the authors (D.F.). After the procedure, patients completed a visual analogue pain scale. Mean recorded pain levels show a 50% reduction in the high intensity group as compared to control (statistically significant, $p < 0.01$) and a 38% reduction in the low intensity group as compared with control ($p < 0.05$). Although TENS undoubtedly has a "placebo" effect, the reduction in recorded pain levels appears large for this and supports the use of TENS, particularly in those anxious about pain.

11.26 – 11.34 am

An ultrasound technique for measuring the coracoclavicular distance of the shoulder [Paper]

V A Sluming
Department of Diagnostic Radiography, Faculty of Medicine, University of Liverpool, Liverpool L69 3BX, UK

The distance between the clavicle and the coracoid process of the scapula is frequently assessed during the radiographic investigation of the acromioclavicular joint. This study defines an ultrasound technique (5 MHz real time linear array) for measuring the coracoclavicular distance, and determines its reliability and validity. The measuring end-points were the superior border of the clavicle and superior border of the coracoid process. 49 subjects participated in the study. Intraoperator and interoperator reliability were evaluated. The ultrasound measurements for 19 of the subjects were validated against the measurement obtained from a shoulder radiograph. The data were subjected to the "limits of agreement" method of analysis. The mean difference between the radiograph and ultrasound measurements was 0.38 mm. The limits of agreement (95% confidence intervals) were -0.57 (-0.97, -0.17) and 1.33 (0.93, 1.73). Intraoperator and interoperator reliability were evaluated with a multifactor ANOVA and gave $p = 0.7162$ for intraoperator reliability and $p = 0.5$ for interoperator reliability. The mean of the coefficients of variation for the two operators was 1.84%. The average range for repeated trials (same operator, same subject) was 1.35 mm. The maximum difference in the averages for each operator was 1.2 mm. The ultrasound technique described is recommended as a reliable, accurate and valid technique for evaluating the coracoclavicular distance.

11.34 – 11.38 am

A comparison of hand-held versus suspended weight for stress examination of the acromioclavicular joint [Poster]

V A Sluming
Department of Diagnostic Radiography, Faculty of Medicine, University of Liverpool, Liverpool L69 3BX, UK

Acromioclavicular joint disruption is frequently evaluated by a radiographic examination of the joint under stress (weight-bearing). Certain authors recommend suspending the weights from the arm, rather than holding in the hand, to allow for total muscle relaxation. This study examines the relationship between the coracoclavicular distance measured and the method of distraction. 30 normal subjects participated in the study, which used ultrasound (5 MHz linear array) to measure the coracoclavicular distance under four conditions (levels of traction): non-stressed, muscle relaxed; non-stressed, muscles tensed; stressed with 7.5 kg weight hand-held; stressed with 7.5 kg

weight suspended from the wrist. The data were subjected to a multifactor ANOVA. The level of traction was statistically significant ($p < 0.001$). The data were then subjected to a Bonferroni multiple comparisons procedure. This showed a difference between the non-stressed and stressed conditions, but there was no difference between the two methods of applying stress to the joint. It was concluded that, in normal subjects, the method of performing the weight-bearing examination does not have a significant effect on the magnitude of the coracoclavicular distance.

11.38 – 11.42 am
Prone oblique CT arthrography of the shoulder: a new position [Poster]
P Turner, P J O'Connor, A Saifuddin, J Williams, P Butt and A Coral
Department of Diagnostic Radiology, St James's University Hospital, Leeds LS9 7TF, UK

Computed tomographic arthrography (CTA) of the shoulder is currently the investigation of choice for the assessment of shoulder instability. 47 patients were investigated by CTA using a prone oblique position to assess its value in demonstrating both anterior and posterior capsules simultaneously. The first five patients were also scanned supine to allow direct comparison with the prone oblique position. All studies were reviewed retrospectively by three musculoskeletal radiologists to compare how well the relevant structures were shown. In the prone oblique position, the anterior capsule was well seen in 98% of cases, anterior labrum 98%, posterior labrum 89%, posterior capsule 91%, subcapsularis tendon 98%, biceps tendon 100% and biceps tendon proximal insertion 78%. In 86% of cases both anterior and posterior structures were seen simultaneously. In the five cases also imaged supine, the prone oblique position was better. The cause of poor demonstration of structures was insufficient intra-articular air. The prone oblique position should be the standard position for CT arthrographic assessment of patients with shoulder instability.

11.42 – 11.46 am
The use of double contrast CT arthrography in the diagnosis of anterior knee pain [Poster]
G J M Goh, R Spencer-Jones, R F Calver and H G Lewis-Jones
Departments of Radiology and Orthopaedic Surgery, Aintree Hospitals, Liverpool L9 1AE, UK

Anterior knee pain is a common symptom, especially in young patients. Maltracking of the patella is a potentially treatable cause but is difficult to diagnose on plain films. We examined the efficacy of CT knee arthrography in the assessment of anterior knee pain: 57 knees in 47 patients with anterior knee pain and a provisional diagnosis of maltracking of the patella were studied prospectively. Clinical information and treatment course were noted and plain X-rays and CT arthrograms were reviewed. Plain X-rays only diagnosed patellar tilt in one patient and subluxation in another. CT arthrography demonstrated significant maltracking in 42 patients. We present the accurate methods used. The clinical management of the patient was altered by CT in the majority of cases: 31 patients had surgery, four refused surgery, and six patients with diagnosed maltracking are under review. 15 patients had mild degenerative change and were treated with physiotherapy. The results highlight the added information available from CT arthrography and its relevance in the management of anterior knee pain.

11.46 – 11.54 am
MRI diagnosis of partial tears of the ACL of the knee [Paper]
[1]J A L Lawrance, [1]S J Ostlere and [2]C A F Dodd
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In an attempt to define the MRI features of partial anterior cruciate ligament (ACL) injuries, we retrospectively analysed the MRI scans of 39 patients who had had an arthroscopy showing either a normal, a partial or a completely torn ACL. MRI correctly predicted 9/9 (100%) complete tears and 10/11 (91%) normal ACL. Only 1/9 (11%) partial ACL tears was correctly diagnosed prospectively. Further analysis of the MRI scans revealed features of the ACL found in 7/9 (78%) patients with partial ACL tears, but rarely in the control groups. These are: the presence of some remaining fibres, thinning of the ACL, a wavy or tortuous ACL and the presence of an inhomogeneous mass lateral to the ACL. We suggest that these findings may be indicators of partial ACL tears.

11.54 – 11.58 am
The os trigonum — an interesting little bone [Poster]
C Charlesworth, G de Lacey and L Wilkinson
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The os trigonum is perhaps one of the most frequently seen accessory ossicles. It is reported as presenting as a separated ossicle in approximately 11% of the population. Other authors have described its incidence at 50% when those fused to the talus are included. Radiologists usually

consider the os trigonum to be an unimportant normal variant and ignore it. However, orthopaedic surgeons recognize that it can become symptomatic and procedures for its excision are described in standard textbooks of surgery of the foot. The os trigonum can fracture and cause pain or it can give rise to symptoms because of disruption of its fibrous attachment to the main body of the talus. Sometimes, when it is partially fused to the talus, the appearance may mimic a fracture. The variety of shapes and various appearances of the os trigonum will be illustrated. Perhaps this interesting little bone should no longer be ignored by radiologists.

11.58 am – 12.02 pm
The radiology of recessive dystrophic epidermolysis bullosa [Poster]
W L Wong, A J Hails, M McGurk and J Pemberton
Departments of Clinical Radiology and Oral & Maxillo-facial Surgery, St Thomas' Hospital, London SE1 7EH, UK

Recessive dystrophic epidermolysis bullosa (EB) is a rare skin condition which often involves the gastrointestinal tract and musculoskeletal system. We reviewed the radiology of 40 patients with recessive dystrophic EB and present the findings from plain film of the extremities and spine, together with the barium swallows and orthopantomograms. Features in the hands and feet included generalized osteoporosis, overtubulation of the bones, flexion contractures, acro-osteolysis, metatarsal and metacarpal subluxation, mitten-hands, soft tissue calcification and retarded skeletal maturity. In the rest of the skeleton hip dysplasia, bony ankylosis of the knees and thoracolumbar scoliosis occurred. Features in the gastrointestinal tract included oesophageal stricture formation, together with decreased peristalsis and pseudo-diverticulum in the oesophagus. There was also a tendency to faecal impaction. In the jaw the radiological features included extensive caries, early tooth loss, crowding of the teeth, hypoplasia of the mandible and malformation of teeth. Although the individual radiological manifestations are non-specific, when taken in constellation they are typical of the condition and complement the clinical and pathological features in establishing the diagnosis.

12.02 – 12.06 pm
Osteomatous jaw lesions in patients with familial adenomatous polyposis coli [Poster]
G M Danesini, P Potepan, A Laffranchi, I Spagnoli, L Bertario, P Sala and A Guzzon
Diagnostic Radiology "A" (RDA), National Cancer Institute of Milan, Milan 20133, Italy

The aim of this study is to analyse by orthopantomography (OPT) the jaw osteomas and the dental abnormalities that frequently occur in the familial adenomatous polyposis coli (FPC), and to assess whether OPT may be useful for routine examination of FPC patients. At the National Cancer Institute of Milan, we reviewed OPT from 1984 to 1992 in 175 patients, as well as a control group of 220 individuals. 93 patients (53%) had osteomas and/or dental anomalies, versus 12 (5.4%) with osteomatous lesions and 28 (12.7%) with dental anomalies in the control group. We finally observed 78 patients (44.5%) with osteomas of the jaw, while dental abnormalities were found only in 37 (21%). Without a genetic and/or biochemical assay for premalignant states of FPC, it is necessary to find a clinical marker that precedes the severe colonic manifestation. OPT, usually performed in young children for common odontological disease, has been suggested as a noninvasive supplementary screening of first-degree relatives. Using this technique, we think it possible to increase the diagnostic sensitivity of FPC, using dental radiographs in conjunction with other diagnostic methods like the search for benign ocular patches.

10.45 am – 12.27 pm

Management

Harewood Suite II

10.45 – 11.10 am
Performance of radiology by non-radiologists: cost and quality issues [Invited Review]
D C Levin
Department of Radiology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania 19107, USA

The aim of this study was to examine cost and quality issues relating to payments by Pennsylvania Blue Shield (PBS) for imaging studies performed by non-radiologists. Data from several different studies performed in conjunction with PBS (the largest private healthcare insurance carrier in the state) will be reviewed. The cost data relate to both average reimbursements for individual codes and aggregate reimbursements. The quality data comes from PBS's and other assessments of image quality among examinations performed by radiologists and non-radiologists. For imaging examinations performed during 1991 in private offices in Pennsylvania, approximately $68 million were paid by PBS for high volume imaging codes. 65% went to non-radiologists. Average reimbursements paid by PBS were higher to non-radiologists than to radiologists for most procedure codes, both in general radiography and ultrasound. The assessment of image quality revealed disturbingly high levels of unsatisfactory quality among examinations performed in offices of non-radiologists. Performance of imaging examinations by non-radiologists leads to costs which may be both unnecessary and excessive on a per-examination basis. Moreover, the quality of imaging examinations by non-radiologists tends to be substandard in a large proportion of cases.

11.10 – 11.18 am
Reporting of accident and emergency radiographs by radiographers: a study to determine the effectiveness of a training programme [Paper]
C F Loughran
Department of Radiology, Macclesfield District General Hospital, Victoria Road, Macclesfield SK10 3BL, UK

A 6 month programme was established to train three radiographers in aspects of accident and emergency radiology. The accuracy of the radiographers' reports was assessed each month. A total of 3595 reports were available for analysis. The overall radiographer error rate declined during the course of the training period. This was highly significant ($p < 0.001$). The sensitivity rate for fracture detection improved from 81.1% at the commencement of the study to 95.9% at the end, also highly significant ($p < 0.001$). It is concluded that suitably trained radiographers could report a proportion of radiographs from the accident department to a high degree of accuracy.

11.18 – 11.26 am
Educational seminars for GPs — what happens — are they worth it? [Paper]
A R Paes, P J Nolan, A Evans and I Gray
Department of Clinical Radiology, The Royal Infirmary, Huddersfield HD3 3EA, UK

The purpose of the study was to try to find out how GPs decide to request radiological examinations and how educational seminars might affect referral patterns. 17 Huddersfield GPs attended two educational seminars. Reasons for referral and perceived value of investigations were recorded over a 6 month period. Referral was often because a diagnosis was sought, but the test was considered more valuable if subsequent management was affected. Patients requested radiological referral much less frequently than expected. Variation was reduced. A significant reduction in referrals has persisted after 2 years. The pattern of reduction is of interest. Educational seminars may be an easy way of reducing radiology referrals. Suggestions are made as to what topics should be included in such seminars.

11.26 – 11.30 am
Going your own way: an independent PC-based computerized management system for radiological subspecialties [Poster]
[1]A Coulthard and [2]A R Wright
[1]University Department of Radiology, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP, UK and [2]X-ray Department, Western General Hospital, Edinburgh EH4 2XU, UK

Radiological subspecialist services such as MRI may benefit from a customized computer system independent of

the Departmental Radiology Management System (RMS). We describe the development of such a system for MRI and discuss its use and advantages compared with the RMS. The system was developed from commercial database software installed onto a 486SX/8Mb PC. The keyboard is sited by the MRI console for access while scanning and replaces the conventional MR logbook. The database (MRLOG) generates a unique MR patient number and contains details including referral information, examination time and scan cost. Data entry is simplified by comprehensive drop-down menus. Sequence information is entered into a second database configured to emulate the MR control screen. Clinical information and diagnostic codes are contained within a third database. All three databases are linked: shared information is automatically entered. Daily back-up routines are incorporated. Complicated databases searches can be performed simply and quickly: reports for financial or medical audit purposes can be printed in minutes. The system is extremely flexible and is easily modified as needs change. A similar system could be designed by anyone with basic computer literacy: the concept is equally applicable to CT, interventional work or any other subgroup.

11.30 – 11.38 am

Electronic data interchange in radiology [Paper]

Radiology Working Group on EDIFACT
Department of Radiology, St James's University Hospital, Beckett Street, Leeds LS9 7TF, UK

A specific structured document designed for electronic data transmission is called a "message". The NHS has decided to adopt the international syntax standard UN/EDIFACT (United Nations Electronic Data Interchange For Administration, Commerce and Transport) as the "technical grammar" for its messsages. The aim of an agreed message format is to simplify the handling of data, to allow communication between multiple users, and to minimize errors in data communication and interpretation. We wish to develop a message to describe the interaction between individual patients and radiology departments, including data on requests, procedures and reports. In order to learn from existing experience in electronic data handling in radiology, we surveyed over 400 hospital radiology departments in the United Kingdom. From the results of this survey and from other consultations, a proposal for the data content of a "radiology message" for national use has been derived. The survey results and the proposed message content will be described in detail.

11.38 – 11.46 am

Provision of scientific services in the reorganized National Health Service [Paper]

[1]P R Raggatt and [2]P P Dendy
Departments of [1]Clinical Biochemistry and [2]Medical Physics, Addenbrookes NHS Trust, Cambridge CB2 2QQ, UK

This paper looks at some of the ways in which reoganization of the NHS has affected the provision of scientific services to patients and examines ways in which such services, and the research and development associated with them, should be led, guided and co-ordinated in the new NHS structure. Health Notice HN(90)18 on the organization and management of scientific services contains an admirable statement of the scope and value of patient-related scientific services and the need for a highly trained workforce concentrated so as to obtain critical mass and efficiency. However, HN(90)18 envisaged a strong Regional co-ordinating role, so that, although the fundamental questions asked in HN(90)18 remain, the answers recommended in 1990 now need revision. The questions are analysed under four main headings: Manpower, Finance, Leadership and Management Quality. The main conclusion of the paper is that both purchasers and providers must ensure that they have appropriate and timely advice on the provision of scientific services to patients, especially in such areas as specification of quality standards, the incorporation of rapidly developing scientific services into the planning process and the close linkage between routine service work and research and development.

11.46 – 11.54 am

How to integrate an X-ray department (or how not to?) [Paper]

N Hudson, R Keal and C Reek
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In January 1994 Groby Road Hospital closed and the facilities and staff moved to a new cardiothoracic unit situated at Glenfield Hospital, 400 metres up the road. This talk illustrates the problems associated with integration of two separate X-ray departments and looks at the outcome of the planning. The staffing structures of both the old and new departments are shown and we discuss how the decisions on the new management structure were made. The results of these changes on staff morale are considered. Numerous other issues are also discussed, including integration of film packets and filing, film and cine storage, clerical, secretarial and receptionist support and contacts with clinicians. The problems of the move were compounded by changes in Senior Management and

Hospital Trust status, together with the devolution of regional specialties to district level. The problems associated with these are also discussed.

11.54 am – 12.02 pm
Introducing confidence in abstracts [Paper]
N J A Cozens
Department of Radiology, Royal Infirmary of Edinburgh, Lauriston Place, Edinburgh EH3 9YW, UK

The aim was to assess the utilization of statistical evaluation and confidence interval (CI) analysis in abstracts from papers presented at the 1993 Annual Congress of the British Institute of Radiology. All the 435 abstracts in the *British Journal of Radiology*, Vol. 68, Congress Supplement were analysed for potential usefulness and inclusion of statistical analysis and confidence intervals. Statistical analysis was considered appropriate in 189 (43.4%) abstracts. Only 54 (28.6%) of these abstracts utilized such analysis: 42/165 (25.5%) of diagnostic radiology abstracts and 12/24 (50%) of clinical oncology abstracts. The difference between these proportions (24.5%) is significant ($\chi^2 = 5.04$, $p < 0.025$; 95% CI of difference is 34.7% to 45.6%). Only two (1%) abstracts quoted confidence intervals. Statistical analysis and confidence intervals would appear underutilized in these abstracts, particularly in diagnostic radiology. To draw valid scientific conclusions from relatively small studies in radiological research, the relevant statistical analysis is crucial. Confidence intervals are especially useful. The utility of confidence intervals will be demonstrated with examples from the analysis in this paper. An annotated bibliography of statistical and confidence interval usage in radiological research will be available.

12.02 – 12.27 pm
Facilitating the purchase of diagnostic and medical equipment [Invited Review]
G A McCormack
Department of Purchasing (Diagnostic and Medical Equipment), National Health Service Supplies Authority, Manchester M20 8PL, UK

This paper is intended to outline the benefits of using an NHS Supplies dedicated professional purchasing team for the procurement of diagnostic and medical equipment. Such a team can provide: (i) access to the skills and experience of professional purchasing staff, who daily deal in the medical equipment marketplace; (ii) information to aid writing of specifications; (iii) the access to economies of scale from local, or other, consolidation of purchases where practical within the customer's time constraints; (iv) dealing with the complications of Public Procurement legislation, the administration, advertising, tendering, and advising on potential legal conflict; (v) advice on the pitfalls associated with leasing, and how to avoid them; and (vi) access to contractual Terms and Conditions which will be enforced on the supplier to meet your needs and protect your rights. The use of professional purchasing teams delivers secure, strong value for money contracts, without jeopardizing local control over the decision making process.

10.45 am – 12.00 noon

Radiation Protection II

Bramham Suite

10.45 – 11.10 am
Patient dosimetry — some practical considerations in an NHS Region [Invited Review]
R M Harrison and K Faulkner
Regional Medical Physics Department, Newcastle General Hospital, Newcastle upon Tyne NE4 6BE, UK

There is a well established need to monitor the doses received by patients undergoing diagnostic X-ray examinations. International requirements for radiation protection necessitate the establishment of risk–benefit relationships, for which the absorbed dose for the examination is a prerequisite. The review will deal with a number of practical issues of implementation within an NHS Region. These will include: (i) the applicability of TLD measurements compared with dose calculations based on tube output QA measurements; (ii) the prospects for automated quality assurance and dosimetry using on-line computing; (iii) doses in computed tomography; (iv) special problems in mammography; (v) regional co-ordination of dose surveys and (vi) the role of patient dosimetry in radiology audit.

11.10 – 11.18 am
Early results and implications from applying the National Patient Dosimetry Protocol in a large teaching hospital [Paper]
L P Readman, D L Asbury and A Hufton
Department of Radiology, Withington Hospital, Manchester M20 8LR, UK

There is a legal requirement to deliver the lowest possible radiation dose consistent with the clinical requirements of radiographic examinations. In order to help achieve this the National Radiological Protection Board, together with the Institute of Physical Sciences in Medicine and the College of Radiographers, have published a National Protocol for measuring patient doses in diagnostic radiology, which can then be compared with guideline reference doses representing current national practice. The Protocol has recently been introduced in the University Hospital of South Manchester (Withington), a 1000 bed teaching hospital undertaking approximately 105 000 examinations annually. Initial measurements were performed using dose–area product meters, and the results indicate, for example, that doses for pelvis and IVU examinations are only 60% and 17%, respectively, of those reference doses. Reducing radiation doses produces a change in the risk-benefit equation. An estimation of the cost involved in achieving this dose reduction against the benefit will also be presented.

11.18 – 11.26 am
Conclusions from a three year dosimetry programme [Paper]
H Warren-Forward
Regional Radiation Physics & Protection Service, PO Box 803, Edgbaston, Birmingham B15 2TB, UK

The study commenced in 1991 and aimed at quantifying the observed variations in entrance doses to patients measured using lithium borate thermoluminescence dosemeters (TLDs). Data are presented on 59 X-ray tubes distributed within the West Midlands Regional Health Authority. Data on the use of applied potential, film/screen speeds, automatic exposure controls and anti-scatter grids have been compared with those published in the National Radiological Protection Board Document R200. Comparisons have also made between the radiographic techniques used, with the technical parameters specified in the Commission of European Communities working document XII/173/90. This has indicated large differences in the applied potentials and use of grids between the two study groups. Analysis of the results has shown several possible sources of dose reduction. One of these is in the modification of departmental policy on the appropriate selection of exposure factors for variations in patient size, and in the reduction of repeat rates where 80% of repeats were due to incorrect exposure settings.

11.26 – 11.32 am

Survey of neonatal radiographic practice in the UK [Paper]

A J Hunt and A J Hince
Medical Physics Department, Poole Hospital, Poole BH15 2JB, UK

Results of a national survey concerning patient dosimetry and radiographic practice in Neonatal Intensive Care (Special Care Baby Units) are presented. A previous study at Poole Hospital has shown that significant dose savings are readily achievable locally by modifications to radiographic technique and choice of appropriate equipment, whilst maintaining image quality. The aim of this study was to see if our local situation reflected the national picture. Information was gathered by means of a questionnaire distributed via local physicist contacts to Neonatal Intensive Care Units throughout the UK. An analysis is given of data received on request rates, range of examinations performed, reject rates, X-ray equipment used, specialist techniques employed and typical patient doses received. The results indicate the lack of appropriate specialist radiographic equipment commercially available, the need for more patient dosimetry to be performed, and greater emphasis being put on staff training for this highly specialized area of radiography.

11.32 – 11.36 am

An audit of patient dosimetry in digital and conventional barium studies [Poster]

J D Hunter, S V Thorogood, C Roobottom and N Ring
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We set out to compare radiation dose to patients in barium enemas in our new digital barium suite (Siemens Polydoros 50S Sireskop 5), installed in 1993, and in our conventional screening unit (Philips Super M80 Diagnost 73) installed in 1981. 300 patients referred for out-patient barium enemas were randomly allocated to either suite. Three radiologists each performed 100 enemas. 50 in each suite. The technique used by all three was essentially the same but technique differed between the two suites; this might be expected with the introduction of new and more complex technology. The goal was a series of images in which the radiologist had diagnostic confidence. Each patient was weighed and body habitus recorded. Patient dose was recorded from both the undercouch and overcouch tubes by two separate Diamentors. All three radiologists found that the dose to the patient in the digital screening unit was less than in the conventional screening unit, with no loss of diagnostic confidence. The average reduction in dose was 20%. The introduction of a digital barium suite in our department has led to an overall reduction in dose to those patients undergoing barium enemas.

11.36 – 11.40 am

Radiation doses to patients from small bowel enema examinations [Poster]

[1]D Hart, [2]P J Haggett, [2]P Boardman, [2]D J Nolan and [1]B F Wall
[1]National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, and [2]Department of Radiology, John Radcliffe Hospital, Oxford OX3 9DU, UK

Data relating to patient dose have been acquired for small bowel enemas performed at the John Radcliffe Hospital, Oxford, on 23 adult patients: dose–area products, fluoroscopy times, and the number of radiographs taken, as well as other parameters relevant to the examination. This information is used to compare the examination procedure at the John Radcliffe Hospital with small bowel enemas and barium follow-throughs performed elsewhere. The mean dose–area product for the 23 examinations is about 7 Gy cm^2 and the mean effective dose is estimated to be about 2 mSv. These doses are intermediate between those arising from barium meals and barium enemas performed in the same room.

11.40 – 11.48 am

A study of equipment-related contributions to radiation doses from barium meal and barium enema examinations [Paper]

C J Martin, S Hunter and C Darragh
Department of Bio-Medical Physics and Bio-Engineering, Aberdeen Royal Hospitals NHS Trust, Aberdeen AB9 2ZD, UK

Dose–area product meters allow contributions to radiation dose from different parts of an examination to be identified. Doses from barium meal and barium enema examinations in five departments in Grampian Region have been analysed and equipment-related contributions compared. Mean dose–area products were between 23 and 66% of national reference levels. Mean contributions from fluoroscopy made up 35–90% of the dose for barium meals in different departments and 30 60% for barium enemas, while the decubitus film made up 10–40% of the dose for barium enema examinations. Differences in doses have been related to equipment performance measurements made during routine QA tests. Factors responsible for differences include image intensifier sensitivity, exposure factors and speed of the radiographic system. If all factors were optimized, radiation doses for fluoroscopic examinations could be reduced to 20% of current reference levels. In the

present study, some reductions in dose have been achieved through changes in exposure factors and film/screen combinations. More significant improvements could be made through purchase of systems with low dose rate image intensifiers. It is important to develop dose performance specifications for new fluoroscopic equipment in order that potential savings in radiation dose to the patient can be achieved.

11.48 – 11.52 am

Organ dose assessment for bronchiectasis and interstitial lung patients imaged with an Imatron CT scanner [Poster]

[1]M C Young, [1]D R Dance, [2]C Collins and [2]M C Pearson

[1]Department of Physics, Royal Marsden Hospital, London SW3 6JJ, and [2]Department of Radiology, Royal Brompton Hospital, London SW3 6NP, UK

The Imatron is a high-speed CT scanner that uses a 210° beam rotation rather than the 360° rotation normally employed. Organ doses, will therefore differ for scans with the patient prone or supine. Patients with lung disease may need to be scanned in either or both of these positions, depending on their clinical diagnosis. Measurements and calculations have therefore been made of the organ and effective doses, to compare the risks for these two configurations. The measurements were made using TLDs on nine female patients (four prone, five supine) and an anthropomorphic phantom. The measurements on patients provided an assessment of the variation of breast dose. For the phantom measurements, the TLDs were distributed to facilitate estimates of appropriate organ doses and effective dose. The calculations used organ dose conversion factors from published Monte Carlo calculations. The results show that for both scanning geometries, the breasts, lungs and oesophagus receive significant absorbed doses, and that the orientation of the patient has an important influence on effective dose. Comparison of measurements with calculations shows good agreement provided care is taken to allow for the asymmetric geometry of the Imatron.

11.52 – 12.00 am

How far can we reduce the radiation dose in paranasal sinus CT? [Paper]

[1]I Zammit-Maempel and [2]C-L Chapple

[1]Department of Diagnostic Radiology, Freeman Hospital, Newcastle upon Tyne NE7 7DN, and [2]Regional Medical Physics Department, Newcastle General Hospital, Newcastle upon Tyne, UK

With the increasing use of computed tomography (CT) to evaluate the paranasal sinuses, irradiation to the lens of the eye should be kept to a minimum. We evaluated the eye dose in 16 patients in coronal CT scanning at 210 mAs (our pre-set) and 100 mAs (our minimum parameters). 5 mm contiguous sections were carried out on a Siemens AR.T scanner with a lithium fluoride thermoluminescent dosimeter taped on to the patient's nasal bridge. A similar technique was also used in 10 further patients to compare the CT dose to conventional three-view sinus radiography. The results showed a mean dose of 9.39 mGy (seven patients, range 7.56–11.44 mGy) at 210 mAs and 3.93 mGy (nine patients, range 2.72–5.34 mGy) at 100 mAs. This contrasted with a mean dose of 0.41 mGy (10 patients, range 0.01–0.82) in plain radiography. There was no appreciable difference in diagnostic quality at the lower mAs settings as noise was minimized by imaging the hard copies at a width of 2400 HU and a level of 200 HU. We conclude that coronal CT scanning of the paranasal sinuses can be performed diagnostically despite reducing the mAs parameters substantially.

12.15 – 1.15 pm

Mackenzie Davidson Memorial Lecture

Royal Hall

Imaging of treated cancer [Eponymous Lecture]

J E Husband
Department of Diagnostic Radiology, The Royal Marsden Hospital, Downs Road, Sutton, Surrey SM2 5PT, UK

The role of imaging in the assessment of patients following treatment for cancer is becoming increasingly important. This is for three major reasons. Firstly, the overall incidence of cancer is increasing in an aging population and, secondly, the information derived from imaging has become more sophisticated over recent years so that currently it is possible to document changes in tumour volume, tumour composition and metabolism. Thirdly, and of particular significance, is the enormous progress which has been made in cancer treatment. Thus, imaging is not only required for decisions on individual patient management but also for determining the efficacy of new therapeutic regimes. Such a high demand for imaging has highlighted several issues which have received only limited attention hitherto. These will be considered under the following broad categories: imaging strategies for service and research, the advantages and limitations of different imaging modalities and the clinical significance of information derived from serial imaging studies.

2.15 – 3.48 pm

Oncology Imaging III

Royal Hall

2.15 – 2.40 pm
Role of radiology in prevention and detection of colon cancer [Invited Review]
G W Stevenson
Department of Radiology, McMaster Medical Center, Hamilton, Ontario L8N 3Z5, Canada

Imaging techniques for colon cancer include barium studies, CT, MR, transabdominal ultrasound (TUS), endoscopic ultrasound (EUS) and endoscopy. In general radiologists use the first four, gastroenterologists the last, and both use EUS. In some countries, such as Japan, Sweden, the UK and Denmark the turf boundaries are less sharp. Cost, safety, patient preference, accuracy and the harm to benefit ratio should all play major roles in the selection of test. Radiologists and gastroenterologists need to study, and publicize, the advantages and disadvantages of each other's as well as their own procedures. Barium enema techniques can permit very accurate assessment for colon cancer. For double contrast barium enema there are standard techniques (St Mark's, 1962), complex techniques for clearing the sigmoid of all puddles. Simplified techniques for minimizing fluoroscopic radiation, and modified techniques for concentrating on the right colon where radiologists will now find 40% of cancers. A radiologist should master all of these, and select them as indicated for specific patients. EUS now has a useful role in the assessment of a few smaller rectal cancers. TUS should be studied as a possible screening tool. Intraoperative ultrasound has a role for liver assessment — who should do it? There are several different protocols for CT in the assessment of colorectal cancer, and the range and purpose of each must be understood by the technologists and by the referring gastroenterologist so that the correct one can be requested and performed optimally for each patient. Finally, endoscopy is a great advance in detection and treatment of polyps and cancer. Its use should be integrated with the deployment of high quality barium enemas so that the greatest benefit is achieved with the least complications and least cost.

2.40 – 2.44 pm
The use of the Nitinol ultraflex oesophageal prosthesis in the management of complicated malignant dysphagia [Poster]
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Metal stents are gaining increasing acceptance for use in the gastrointestinal tract, especially in patients with inoperable malignant disease. To date we have used Nitinol stents (Ultraflex, Microvasive, Watertown MA, USA) in four patients with complicated dysphagia in whom surgery was deemed inappropriate. The self-expanding stent is delivered into the gastrointestinal tract, compressed on an introduction catheter with an outer diameter of 8 mm (24F). The stent is deployed following balloon dilatation of the stricture. Two patients had developed fistulation from the oesophagus or cardia following medical intervention; a 65-year-old man who had undergone a previous palliative gastrectomy had developed a recurrence with multiple fistulae into the small and large bowel. The second patient, a 60-year-old woman, had a dilatation for a malignant stricture, following which she developed a perforation at the site of the stricture. This large blind-end tract failed to close after one month of conservative management. In both patients, following placement of an Ultraflex oesophageal prosthesis the fistulae closed and the patients were able to swallow normally. Two other patients with dysphagia from post-operative recurrence of distal oesophageal tumours have been managed using the Nitinol stent. Both were successfully palliated. We describe the technique of stent insertion and the advantages of this stent in difficult situations, as illustrated by the above cases.

2.44 – 2.48 pm

Normal mediastinal lymph node size in an Asian population [Poster]

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The purpose of this study was to assess normal mediastinal lymph node size in an Asian population. Chest CT scans of all Asian patients over a 5-year period were reviewed, and those with pulmonary disease, malignancy or grossly distorted mediastinal anatomy were excluded. The study group consisted of 48 patients (26 M, 22 F) ranging in age from 10 to 75 years, with a mean of 47 years. All nodes greater than 7 mm were measured and their site recorded according to the American Thoracic Society (ATS) lymph node map definitions. 81% of patients had nodes < 7 mm at all ATS stations, 10% had nodes $> 7 < 10$ mm, and 8% had nodes > 10 mm (mean 11 mm). All nodes measuring > 7 mm were in regions 4R, 10R and 7. 14 patients had signs of previous tuberculosis, and in this subgroup 50% had nodes > 7 mm, as compared with 6% in the subgroup with no signs of previous tuberculosis (χ^2 value $p < 0.001$). The high incidence of tuberculosis in Asian patients leads to a higher prevalence of mediastinal nodes measuring 7–10 mm than in the general British population. Despite these differences the generally accepted criteria for normal mediastinal lymph node size (≤ 10 mm) can still be applied to an Asian population when staging lymphoma or bronchogenic carcinoma.

2.48 – 2.56 pm

Management of dysphagia using the Strecker oesophageal stent [Paper]

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The efficacy of an expanding metal stent for the relief of severe dysphagia has been assessed. Between July 1992 and November 1993, 14 patients with severe dysphagia (11 men, three women, age range 51–82) have been managed by insertion of the Strecker oesophageal stent. The cause of dysphagia was carcinoma of the mid-oesophagus in five patients, carcinoma of the cardia in three, recurrent tumour at an oesophagogastric anastomosis in one, extrinsic compression from metastatic disease in four and a benign stricture from previous sclerotherapy in one patient. Patients have been followed up for a maximum of 4 months, and eight patients have died so far. Swallowing was improved in 11 patients, allowing fluids and a soft diet. Tumour ingrowth through the stent has not been encountered so far. The Strecker oesophageal stent is an effective palliation for severe dysphagia in patients with a limited life expectancy.

2.56 – 3.00 pm

Ultrasonic assessment of hemidiaphragmatic excursion in the staging of bronchial carcinoma; comparison with CT and mediastinoscopy [Poster]

J G Houston, R M Angus, M Fleet, M D Cowan and G M Baxter
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In patients with newly diagnosed bronchial carcinoma, hemidiaphragmatic paralysis due to invasion of the phrenic nerve by mediastinal involvement has been taken to indicate inoperability. PA chest radiograph finding of an elevated ipsilateral hemidiaphragm is, however, a non-specific sign, as it maybe due to pulmonary collapse etc. We have recently described and evaluated a technique using ultrasound for the assessment of hemidiaphragmatic movement, in particular to define normal ranges of movement of specific sign, as it may be due to pulmonary collapse etc. We have recently described and evaluated a technique using ultrasound for the assessment of hemidiaphragmatic movement, in particular to define normal ranges of movement of each hemidiaphragm. This study of 30 patients with newly diagnosed non-small-cell bronchial carcinoma undergoing staging with a view to surgery compares plain chest radiography, thoracic CT, and mediastinoscopy findings, with hemidiaphragmatic ultrasound as indicators of phrenic nerve involvement in mediastinal invasion. Ultrasound is a simple means of examining hemidiaphragmatic movement and may be performed as an adjunct to the standard upper abdominal ultrasound examination used in staging.

3.00 – 3.08 pm

Spiral CT imaging of the pulmonary hila in lung cancer: role of multiplanar display in patient management [Paper]

A R Padhani, E K Fishman, R F Heitmiller, K P Wang, J H Wheeler and J K Kulhman
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We set out to evaluate the value of spiral-generated multiplanar reconstructions of the pulmonary hila in the assessment of patients with central lung cancer. 12 patients with non-small-cell lung cancer and hila abnormalities were examined with contrast-enhanced spiral CT. Studies were performed on a Siemens Somatom S or Plus S scanner

using either a 24 or 32 s spiral. The study volume was from the arch of the aorta to the inferior pulmonary veins, done in a single breath-hold, using 4 mm collimation and reconstructed at 2 mm intervals. We assessed the quality of vascular enhancement and of multiplanar reconstructions. Our results were correlated with bronchoscopic, surgical and pathological findings. Excellent vascular opacification and good quality reconstructions were obtained in all patients. No interscan motion was detected. Optimal definition of lymph node groups allowed accurate staging. The additional information provided by the multiplanar display was helpful for problem solving, for the planning of bronchoscopically guided biopsy and for endobronchoscopic laser therapy. Spiral-generated multiplanar reconstructions of the hila are helpful for staging, problem solving, guiding bronchoscopy and surgical planning. Even patients with limited respiratory reserve can successfully complete the examination.

3.08 – 3.16 pm

The role of Magnetic Resonance Imaging and cine MRI in bronchial carcinoma — a comparative study [Paper]

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The role of MRI in the thorax is not as yet clearly defined. We prospectively examined 30 patients suspected of having bronchial carcinoma on plain radiography and computed tomography. Sequential images were obtained using a Siemens 1 Tesla Magnetom scanner to obtain coronal multiecho T_1 and STIR images and axial T_2 and cine 2D images through the mediastinum. Images were examined by two radiologists independently without access to, or prior knowledge of, the previous investigations. In all patients the suspected tumour was well demonstrated by MRI, particularly on the STIR sequences. Cine 2D images were complementary as they were superior in differentiation between vessels and soft tissue masses. The cine images also helped to decide whether there was vascular involvement in those tumours adjacent to the mediastinum. MRI was however inferior to computed tomography in the demonstration of central bronchial involvement. In conclusion, we believe that CT and MRI are complementary in the diagnosis and staging of suspected bronchial carcinomas. Their respective places and indications and the role of intravenous contrast medium will be discussed.

3.16 – 3.20 pm

Non-treatment of large hydropneumothoraces after therapeutic thoracentesis for malignant disease: recognition of a new entity [Poster]

M M J McNicholas, G W Boland, G S Gazelle, P R Mueller, M J Lee, M Girard and C C Neff
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Increasing experience with ultrasound guided therapeutic thoracentesis for malignant effusions has led to the recognition of an uncommon complication of failure of lung re-expansion resulting in asymptomatic pneumothorax. A retrospective review of 445 patients who underwent 512 therapeutic thoracenteses for malignant effusions over the past 5 years, was performed to determine the incidence and outcome of this entity. Chart reviews were conducted in order to determine the volume of fluid removed, complications encountered, treatment rendered, and outcome. Large hydropneumothoraces were noted in 17/512 (3.3%) cases. The average volume of fluid drained was 1200 ml (range 750–3000 ml). In the majority of cases, despite chest X-ray evidence of a pneumothorax of up to 75% in size, only minimal symptoms were noted. Tube thoracostomy, which was performed in all patients, failed to re-expand the lung. After a variable time (3 days to 3 weeks) fluid re-accumulated in the pleural space. All cases showed evidence of malignant parenchymal lung disease. Asymptomatic pneumothorax after drainage of malignant pleural effusions can occur in patients with underlying malignant parenchymal disease. Its recognition is important in order to avoid unnecessary thoracostomy, as fluid will re-accumulate to fill the pleural space.

3.20 – 3.28 pm

Ultrasound-guided placement of small-bore catheters for drainage and sclerotherapy of malignant pleural effusions [Paper]

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Symptomatic pleural effusion is a common occurrence in advanced malignant disease. The purpose of this study was to see if effective drainage and pleurodesis could be achieved with the use of small-bore catheters. 36 patients with malignant pleural effusions were referred for insertion of small-bore (12 French) catheters with ultrasound guidance over a 13-month period. 29 went on to have pleurodesis with tetracycline. There was no recurrence of pleural effusion in 22 of the 29 patients (76%) at the time of the

most recent chest radiograph. Seven patients had a significant recurrence of effusion of at least 30% of the volume of the hemithorax. One of these developed an empyema after unsuccessful pleurodesis, treated with reinsertion of a catheter. Another patient with malignant mesothelioma had two failed attempts at pleurodesis and eventually underwent thoracotomy with talc poudrage. There were no serious complications. Ultrasound-guided placement of small-bore catheters appears to be an effective and safe procedure for the drainage and sclerotherapy of malignant pleural effusions, with a success rate comparable to that for conventional larger chest tubes.

3.28 – 3.36 pm

The effect of spiral CT pitch on the detectability of lung metastases [Paper]

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Spiral CT (SCT) has been shown to be superior to conventional CT in the assessment of pulmonary nodules with regard to lesion detectability, slice misregistration and breathing artefact. Further technical advances in image reconstructions have allowed spiral scanning with increased pitch, where the scanning helix is elongated by use of a higher table speed. Potential advantages include reduction in radiation dose, larger maximum scan volume and further decrease in breathing artefact. However, the effect of increasing the scan pitch on the detectability of lung nodules is unknown. In a prospective study, 100 patients with pulmonary metastases received a standard SCT chest scan, and the same volume was re-scanned using increased-pitch SCT. For the additional examination, patients were randomized to receive a scan of pitch 1.2, 1.5 or 2.0, with reconstruction of contiguous slices throughout. All technical and patient data were removed from the hard-copy images of the increased-pitch scans to reduce bias. Two independent observers reviewed all standard and increased-pitch scans for number and distribution of metastases, and presence of breathing artefact. Preliminary analysis indicates that increasing the spiral pitch has no significant effect on detectability of pulmonary metastases or tumour staging. Full results are presented and the clinical implications of increased-pitch scanning are discussed.

3.36 – 3.40 pm

Multiple cavitating lung lesions in non-Hodgkin's lymphoma [Poster]

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We present two patients with multiple cavitating pulmonary lesions as a manifestation of non-Hodgkin's lymphoma. In the first case this was the primary presenting feature in a patient with anaplastic large cell Ki 1 lymphoma. To our knowledge this is the first report of cavitating lung nodules in this particular subtype of non-Hodgkin's lymphoma. In the second case, a patient with diffuse large cell lymphoma developed cavities in pre-existing lung nodules which increased in size during the course of his disease. We review, with examples, the spectrum of pulmonary findings in non-Hodgkin's lymphoma, including a number of secondary complications which manifest in the lungs. Cavitating lung nodules are an unusual feature in non-Hodgkin's lymphoma. They have previously been described almost exclusively in patients with the more aggressive forms of non-Hodgkin's lymphoma and are likely to reflect rapid tumour growth. The importance of considering this condition in the differential diagnosis of cavitating pulmonary lesions is emphasized.

3.40 – 3.48 pm

Normal pelvic lymph nodes: documentation by CT scanning after bipedal lymphangiography [Paper]

S J Vinnicombe, A Norman, V Nicholson and J E Husband
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The study aim was to assess the numbers and size of normal lymph nodes shown on CT before and after lymphangiography (LAG). CT scans were assessed 3–4 months after LAG in 40 patients on surveillance for Stage I testicular tumours, and in 27 of these immediately before LAG. The site, size and number of nodes were documented by two observers. Maximum short axis diameter (MSAD) was measured at four sites (common, external and internal iliac, and obturator). Results were analysed histographically and median and centile values calculated. 187 nodes were measured on pre-LAG CT. The median MSAD at each site was 3 mm. No nodes were larger than 8 mm. 1864 nodes were measured on post-LAG CT. All median MSAD values post-LAG CT were 5 mm or less; under 2% of nodes had an MSAD greater than 10 mm. Medians and centiles were larger in external and common iliac sites. Almost all normal pelvic nodes are less than 10 mm in diameter: the size varies according to site. The low sensitivity of CT for nodal metastases might be improved by adopting the following upper limits of normal for nodal MSAD: internal iliac, 7 mm; obturator, 8 mm; common iliac, 9 mm and external iliac, 10 mm.

2.15 – 3.48 pm

MR Technology

Ripley Suite

2.15 – 2.40 pm

Tissue-specific contrast agents for MRI [Invited Review]

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Contrast agents available today such as Magnevist®, Omniscan® or ProHance® display a high efficacy for enhancing lesions. Their differential distribution in compartments like the vascular, extra- and intracellular space, is a prerequisite for their contrast enhancement. The said agents distribute in the interstitial space and are subject to glomerular filtration. By their selective excretion higher concentrations are reached in the kidneys. A tissue-specific accumulation in other areas does not occur since the interstitial space does not differ much between major organs and focal lesions. The goal is to develop compounds with selective uptake. Besides various strategies using specially coated superparamagnetic particles for receptor targeting and polymeric Gd-compounds as blood-pool-agents, liver-specific materials are by far the most promising and advanced agents. After iv injection, hepatocyte-specific T_1-agents (MnDPDP [Nycomed], GdBOPTA [Bracco] and Gd-EOB-DTPA [Schering]) are subject to a specific carrier-mediated accumulation. While MnDPDP and GdBOPTA are only poorly eliminated by the biliary route, Gd-EOB-DTPA undergoes equal and complete excretion into the urine and faeces in animals and man. The T_2-agents (AMI-25 [Advanced Magnetics] and SH U 555 A [Schering]) are based on superparamagnetic iron oxides (SPIO) and accumulate in the von Kupffer cells of the liver. Because of the extremely high potency of SPIO the uptake in this small cell population is sufficient to decrease the signal intensities of the normal liver parenchyma. The metabolized iron is not excreted but enters the normal iron pathway (ferritin, haemosiderin, haemoglobin). In both cases, very small quantities as small as 10 μmol kg^{-1} are sufficient to contrast the liver. Experimental studies in animals and first clinical results demonstrate the efficacy for improving the detection and characterization of focal liver lesions.

2.40 – 2.48 pm

Contrast-enhanced MR imaging of experimentally induced liver abscess using a new Gd complex as MR contrast agent [Paper]

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To evaluate the diagnostic efficacy of Gd BP-DTTA in enhancing focal liver lesions, a laboratory study using an animal model of hepatic abscess in rats was performed. Pyogenic liver abscess was induced in male Wistar rats by implanting a gelatine capsule containing a bacteria solution into the liver parenchyma. 5 days after surgery, imaging was performed on a 1.0 T magnet (Siemens, Magnetom). Pulse sequences included T_1-weighted spin echo (SE) sequences with a repetition time (TR) of 400 ms and an echo time (TE) of 15 ms, an SE 600/15 sequence and a T_2 weighted SE 1800/15 sequence. Using Gd BP-DTTA as MR contrast agent, the contrast between abscess and liver was increased by enhancement of the abscess wall as well as by enhancement of normal liver tissue. The abscess wall showed an increase of signal intensity (SI) up to 82%, whereas in normal liver tissue the increase was up to 58%, and in the abscess cavity no significant change of SI could be measured. Unenhanced T_1-weighted and T_2-weighted MR images showed no specific morphological features that can be used to distinguish intrahepatic abscesses from metatases. Using the new Gd complex as MR contrast agent, in T_1-weighted images the conspicuity of hepatic abscesses increased remarkably. Regarding these results, Gd BP-DTTA can be categorized as a potential new contrast agent for MR imaging of the liver.

2.48 – 2.52 pm

Contrast-enhanced MR imaging of experimentally induced acute pancreatitis, using Mn BP-DTTA as MR contrast agent [Poster]

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To evaluate the clinical usefulness of contrast-enhanced MR imaging in acute pancreatitis, a new Mn complex was tested in an animal model of experimentally-induced pancreatitis in pigs. Six female pigs were anaesthetized by intravenous sodium barbital injection and following laparatomy the pancreatic duct was cannulated. After injection of 0.1 ml ethanol and 0.08 ml sodium chloride solution kg $^{-1}$ bodyweight, the pancreatic duct was ligated and the abdomen was closed in double layers. 24 h after surgery, T_1 weighted images (TR/TE = 600/15 ms and TR/TE = 400/15 ms) were made on a 0.5 T magnet (Gyroscan, Philips) before and after giving contrast medium. MR images were compared with corresponding CT scans. In unenhanced MR images of the pancreas, only a swelling of the organ could be observed. Following injection of contrast medium, an inhomogenous contrast enhancement in the pancreas could be demonstrated. Thus vital and necrotic tissue could be differentiated with good correlation with CT scans. Regarding the results of our study, the new Mn BP-DTTA complex might be useful in MRI of the pancreas, and further studies have to prove whether the new medium is also useful for imaging of pancreatic neoplasms.

2.52 – 3.00 pm

Use of a super paramagnetic iron oxide contrast agent in MRI of focal liver lesions [Paper]

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AMI-25 (Laboratoire Guerbet) is a colloidal solution of superparamagnetic particles of iron oxide with a low molecular weight dextran coating. When administered by slow intravenous injection, it is taken up by the reticulo-endothelial system (RES) of the normal liver, resulting in significant shortening of the T_2 relaxation time. Lesions without RES activity fail to accumulate contrast medium. We have studied 16 patients (nine men, seven women; age range 36–68, mean 49 years) with focal liver lesions, using a 0.5 Tesla superconducting MR system (IGE Vectra). All patients had one or more lesions previously demonstrated by ultrasound or CT. Six patients had benign lesions, six secondary and four primary malignancies of the liver. All patients were imaged before and after infusion of 0.075 ml kg^{-1} bodyweight of AMI-25. Comparison of the images obtained before and after contrast showed significant reduction of signal on T_2 and proton density weighted images in all but one patient, with corresponding increases in liver/lesion contrast. The number and extent of lesions were demonstrated more clearly using AMI-25 than on T_1 and T_2 weighted sequences normally used for liver imaging. No patient experienced any adverse reaction. Our findings suggest that AMI-25 is a safe and effective contrast agent.

3.00 – 3.08 pm

Modelling and experimental results for tissue response to temperature in MRI using magnetization transfer sequences [Paper]

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[1]Robert Steiner MRI Unit and [2]Medical Physics Department, Hammersmith Hospital, London W12 0HS, UK

We wished to improve our understanding of the possible behaviour of tissue during hyperthermia, with the aim of developing MRI as an on-line means of monitoring therapy. Modelling was done using relatively complex relationships, both in the case where a change in proton density was included (as follows increased perfusion, for example) and in its absence (as might be the result of a very short thermal look), using various magnetization transfer (MT) sequences, including MT-STIR, in which the MT effects on muscle result in it being nearly the same T_1 as fat at the field of the experiments (0.15 T). Experiments were conducted with volunteers, using water bags and radio-frequency hyperthermia at 27 MHz in a Picker prototype machine operating at 0.15 T. Transverse images were acquired with a series of MT sequences as the muscle temperature was varied. The modelling shows that the response to be expected is complex, and this was observed in the experimental work. The MT-STIR was predictably the most sensitive method, but had low signal-to-noise and great sensitivity to motion artefact. Temperature coefficients for a variety of MT parameters were measured. We concluded that the use of MT can afford additional insight in evaluating temperature effects *in vivo*. Some of its temperature coefficients are quite significant.

3.08 – 3.12 pm

A radiofrequency EPR spectrometer for medical imaging [Poster]

A D Stevens, C M Smith and G R Cherryman
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Electron paramagnetic resonance (EPR) detects species with unpaired electrons. There is increasing interest in the development of instrumentation for, and the application of, EPR spectroscopy/imaging techniques to the study of endogenous free radicals and exogenous spin labels *in vivo*, including their use for the measurement of oxygen concentrations from T_2^* and T_1 effects. We have constructed a radiofrequency instrument which will be used for animal and, eventually, human studies. The imager uses continuous wave radiation at 250 MHz. The magnet bore is 0.5 m and field gradients of up to 40 mT m^{-1} are applied. The resonator is constantly tuned to a low-noise crystal oscillator source and can be used in whole-body or surface coil modes. An electronic phase shifter is used to minimize phase-error noise. Back-projection image reconstruction methods — deconvolution, least-squares and maximum entropy — are used. The concentration sensitivity is 4×10^{-7} M. *In vitro* images indicate that a resolution of about 5 mm can be obtained *in vivo* using concentrations of spin labels in the range of 0.2–1.0 mM and scan times of 30 min. The instrument is the largest and most sophisticated of its kind. Sensitivity is remarkably good considering the low frequency operation, and useful EPR images are expected from future studies using gerbils and rats.

3.12 – 3.20 pm

Automatic segmentation of MR images [Paper]

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MR image segmentation is usually guided by demarcation by trained operators of exemplar regions for each tissue type. Exemplar pixel intensities are used to define intensity ranges for tissue types. We describe a method of automatic exemplar selection which improves reproducibility by eliminating operator variability. An improved segmentation method is also described. 31 contiguous slices were acquired in the Talairach plane on a 1 T Siemens SP42E imager using a double spin-echo sequence, SE/3565/(20 and 90). Intensity histograms were generated for T_2 weighted (T_2-W) and proton density (PD) images. Peaks in smoothed histograms were used to select centres of ranges of exemplar values. T_2-W image was used for white matter and CSF; PD image was used for grey matter. Exemplar intensities were used to compute intensity distributions for each tissue type. Skewed distributions were normalized using roots or natural logs of intensities. Five standard deviations on either side of the distribution mean were used to specify intensity limits. Minimum Mahalanobis distance was used to assign partial volume pixels. Pixel labelling was modified by the application of rules which permit a more physiologically plausible and radiologically acceptable segmentation. This is necessary in cases like grey matter pixels within the thalamus, presenting intensities very similar to white matter in PD images.

3.20 – 3.24 pm

Functional MRI at 1 Tesla [Poster]

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To date functional images have been obtained using EPI or gradient echo (GE) imaging at field strengths of 1.5 T or greater. Here we evaluate the feasibility of functional imaging using a standard Siemens SP42E 1T system. A three-slice GE sequence (TR = 91 ms, TE = 60 ms, flip angle 40°, slice thickness 5 mm, MA = 64 × 128) developed at Great Ormond Street Hospital evaluated functional activation. *Motor cortex.* Transverse scans were taken through the motor cortex of five volunteers. The subject alternately touched the fingers of the right hand sequentially and repetitively to the thumb or rested while measurements were made in blocks of eight to a total of 64. *Visual cortex.* An 8 Hz stroboscopic light source was placed outside the window of the scan room. A mirror positioned on the head coil reflected light onto the subject's eyes. The light was on for eight measurements and off for eight as above. The sum of images collected during the "off" periods was subtracted from the sum of the "on" images. Bright areas were clearly seen in the cortex. Regions of interest (ROIs) were drawn in the bright areas. The image intensity of these ROIs on the measurement images showed periodic elevation during the "on" periods. Apparently the strong field dependence in susceptibility imaging noticed at higher fields does not apply to the same extent at 1 T, making functional imaging possible.

3.24 – 3.32 pm

Binomial composite pulses in chemical shift and magnetization transfer contrast imaging [Paper]

[1]X P Zhu, [1]C E Hutchinson, [1]J M Hawnaur and [2]C J Taylor
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Composite binomial pulses have been used to generate magnetization transfer (MT) contrast images on medium

and high field clinical MR scanners, with the advantage of higher dose efficiency and lower demand on the radio-frequency (rf) amplifer than continuous wave (CW) methods. Based on the assumption that "composite" pulses excite bound water whilst leaving water and fat unperturbed, fat can be used as a convenient reference for comparison of tissues demonstrating active MT. Direct fat suppression can, however, occur in MT imaging from "bleeding over" of pre-saturation rf into the spectral line of fat, causing inhomogeneous loss of fat signal and problems in MT quantification. The aim of this study was to establish the contrast variations due to non-specific fat suppression in pulsed MT experiments, especially when using binomial pulses with high flip angles. A computer simulation of the Bloch equation was used to analyse the behaviour of composite pulses with flip angles of up to 280°. Studies on phantoms and *in vivo* were carried out to verify the predictions from the Bloch equations. Volunteers and patients were scanned using the high flip angle binomial composite, *e.g.* $1\bar{2}1$, pulses. All experiments were carried out in a 0.5 Tesla GE Vectra system. The results show that on-resonance $1\bar{2}1$ pulses with short duration, $T \ll 1/\sigma$, where σ is the chemical shift between fat and water, had the least 'bleed over' effect on fat and the free water pool. A long-duration pulse, $T = 1/\sigma$, and off-resonance $1\bar{2}1$ pulses cause direct saturation of fat and/or water. Fat suppressed images obtained by the on-resonance composite pulse and off-resonance pulse were compared with images using a classical $1\text{-}\tau\text{-}\bar{2}\text{-}\tau\text{-}1$ pulse train for contrast between fat and aqueous tissues. The off-resonant $1\bar{2}1$ pulse can be applied in much shorter time without significant degradation of image quality.

3.32 – 3.40 pm

New steady-state 3D sequence for MR imaging of the knee joint: clinical results [Paper]

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Standard steady state sequences generate two echoes simultaneously of which the first has predominantly T_1/T_2 signal characteristics whereas the second displays stronger T_2^* effects. The aim of this study was to add the T_2^* information from the second echo to the arthrographic information from the first echo and to evaluate the clinical benefits. 150 knee joints of orthopaedic patients were examined with 3D gradient echo steady state sequence with parameter settings of TR/TE 1/TE 2/FA = 30 ms/10 ms/40 ms/40° (FISP.PSIF sequence), matrix = 256, acq. = 1 and scan time = 8.14 min with a 1.5 T machine. The two signals were added after the acquisition. The combined image was compared with the original T_1/T_2 weighted first echo (FISP) in terms of signal-to-noise ratio (SNR) and contrast. The combined image showed an increase in SNR and in contrast by an increment of 80% and 30% for fluid and fat, respectively, compared with the first echo alone. The combined image can be more valuable in routine evaluation of the joint pathologies compared to the standard steady state FISP sequences, due to its better SNR and contrast.

3.40 – 3.48 pm

A novel U-shaped radiofrequency coil for high-resolution magnetic resonance imaging of metacarpophalangeal joint arthropathies [Paper]

J Gasson, M E Fry, I R Summers and W Vennart

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This paper presents the design, evaluation and application of a novel geometry radiofrequency (RF) coil for high-resolution magnetic resonance imaging (MRI) of the first, second and fifth metacarpophalangeal (MCP) joints. These joints are involved in numerous arthropathies but hitherto MRI investigations have used adapted coils, such as for the knee, that enclose the whole hand and thus limit the ultimate resolution obtainable for individual joints. The design is based on a conventional cylindrical geometry, 8-leg "birdcage" coil which has been split along one leg and then projected onto a U-shaped cross-section acrylic former. The spacing and thickness of the end legs were altered to obtain optimum RF uniformity and rapid roll-off of the RF field to avoid excitation of surrounding tissue structures. This coil has been used on a Magnex Scientific 1.1 T 31 cm diameter superconducting magnet driven by a Surrey Medical Imaging Systems console. Close agreement has been obtained between theoretical and experimental RF field uniformity plots. Images of normal, rheumatoid and osteoarthritic MCP joints have been obtained with in-plane resolution of 100–200 μm and 1 mm slice thickness. This coil enables MRI of the MCP joints at a resolution demonstrating synovial and cartilage alteration in fine detail.

2.15 – 3.48 pm

Chest Imaging

Harewood Suite I

2.15 – 2.40 pm

A multimodality approach to diagnostic imaging in pulmonary embolism [Invited Review]

P O Alderson

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Diagnosis of pulmonary embolism (PE) continues to be a controversial subject despite the results of the large prospective NIH trial (PIOPED) that compared scintigraphy with angiographic diagnosis of PE. Femoral vein compression ultrasound, high speed CT and MR angiography also appear to be capable of new and meaningful contributions. Integration of these various approaches requires knowledge of each technique's particular strengths and of the natural history of PE. Scintigraphy is sensitive but non-specific. Angiography is reasonably definitive, but not a plausible screening examination. As shown in PIOPED, when scintigraphy yields a definite high or low probability for PE in concordance with the clinical impression, the results are highly reliable. A large indeterminate group typically remains, however. In these patients, MRI and ultrasound can be effective in diagnosing deep venous thrombosis (DVT). MRI can detect PE in the central pulmonary vasculature, while high-speed CT seems capable of visualizing PE in second- to fourth-division pulmonary vessels. The possibility of using perfusion scintigraphy as a road map for high-speed CT or MR angiography of the pulmonary vessels is attractive. Successful integration of scintigraphy with these new types of venous and pulmonary vascular imaging will almost surely improve efficiency and diminish the risk involved in diagnosing PE by imaging.

2.40 – 2.48 pm

The role of computed tomography and fibroptic bronchoscopy in the evaluation of haemoptysis. A comparative study [Paper]

[1]P A K Set, [1]C D R Flower, [2]I Smith, [2]A Cahn, [2]O Twentyman and [2]J M Shneerson

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91 patients (64 men and 27 women, mean age 63 years, SD 14 years) presenting with haemoptysis were investigated prospectively, using high-resolution computed tomography (HRCT) and fibroptic bronchoscopy. Overall, 35% of patients had an underlying malignancy: 85% of the tumours involved the central airways and 80% of the bronchial carcinomas were advanced (Stage III disease). CT detected all 27 tumours seen on bronchoscopy and an additional seven. The incidence of bronchiectasis was 15%. In patients with a normal chest radiograph a bronchial carcinoma was detected in 5% by both bronchoscopy and CT. In patients with an abnormal chest radiograph, bronchoscopy both located and provided a histological diagnosis in 78% of the carcinomas, but was unreliable for peripheral tumours, which were demonstrated by CT. CT was insensitive in the diagnosis of early mucosal abnormalities, bronchitis, squamous metaplasia and a benign papilloma, all of which were detected by bronchoscopy. When there is a high clinical suspicion of a carcinoma and a relevant radiographic abnormality, bronchoscopy should be the initial investigation. CT should be the initial investigation in patients with a normal chest radiograph and should also be used when a strong clinical suspicion of carcinoma has not been substantiated by bronchoscopy.

2.48 – 2.56 pm

Colour Doppler sonography in the evaluation of pulmonary lesions [Paper]

A D Tasker and F V Gleeson

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Colour Doppler sonography has been used in the diagnosis of pulmonary sequestration. We describe the use of this technique in the evaluation of non-congenital pulmonary lesions. 23 adult patients with pulmonary lesions abutting the pleura were studied with grey scale and colour Doppler ultrasound. Flow was detected in each case. Patients could be separated into those with lesions demonstrating normal branching or those with randomly orientated vascular patterns. Normal branching patterns were demonstrated in seven cases of pneumonia: post-obstructive consolidation, three; rounded atelectasis, three; lobar collapse, two; and

cystic fibrosis with lobar collapse, two. Abnormal flow patterns were demonstrated in six patients, five with tumour and one with sarcoidosis. Chest X-ray, CT and ultrasound were available in all cases. Histology was available in all cases of malignancy and for the patient with sarcoidosis. All the remaining patients were followed up for more than 6 months. We believe that this technique may help to evaluate the nature of focal pulmonary lesions abutting the pleura.

2.56 – 3.00 pm
Leiomyosarcoma of the pulmonary artery [Poster]
H M Shannon, C M Turnbull and A J A Wightman
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Primary pulmonary artery sarcoma is a rare tumour with a very poor prognosis. The few reported curative resections of the tumour, and, in one case, heart and lung transplant, have occurred when the diagnosis was made at an early stage. Diagnostic problems arise because of the infrequent occurrence of the tumour and also because it closely mimics other more common disorders such as chronic pulmonary thromboembolism. We report three cases of pulmonary artery leiomyosarcoma referred to a cardiothoracic unit within 5 years. In all three cases the diagnoses were delayed, and finally confirmed at thoracotomy. However, in the most recent case the diagnosis of primary pulmonary artery neoplasm was made with transoesophageal echocardiography and computed tomography of the chest with spiral acquisition, neither of which have been previously reported. Transoesophageal echocardiography showed the presence of tumour in the main and right pulmonary artery with characteristic "to-and-fro" motion previously documented at angiography. Because of its unique ability to acquire a volume of tissue in a single breath-hold, spiral acquisition CT was able to demonstrate clearly the precise extent and nature of the primary intraluminal mass and pulmonary nodules. The use of these newer techniques may facilitate the early diagnosis of pulmonary artery sarcoma and improve its grim prognosis.

3.00 – 3.08 pm
CT-guided needle biopsies of pulmonary lesions: sensitivity, specificity and typing accuracy in 315 cases [Paper]
[1]S Biesterfeld, [2]K-C Klose, [1]S Hauptmann and [1]A Böcking
Departments of [1]Pathology and [2]Radiological Diagnostics, Technical University of Aachen, D-52057 Aachen, Germany

We report on sensitivity, specificity and typing accuracy in 315 needle biopsies of pulmonary lesions under CT control with known follow-up. Most of the biopsies (258) were performed as fine needle aspiration biopsies using a 22-gauge spinal needle, the remaining as punch biopsies, using a 14-gauge Trucut-needle (57). The sensitivity was 99.0% for fine needle biopsies and 98.2% for punch biopsies. Specificities were 93.2% and 100%, typing accuracies 98.0% and 98.5%, respectively. False positive diagnoses concerned regenerating epithelium and chondrohamartoma. In conclusion, CT-controlled fine needle biopsies and punch biopsies of the lung are methods of comparably high sensitivity and specificity which should replace surgical exploration. However, the typing accuracy was found to be higher after punch biopsy. The radiologist may decide upon needle size depending on tumour localization, possible pathways and tumour entities to be expected.

3.08 – 3.16 pm
HRCT of bronchiectasis: the significance of low attenuation areas [Paper]
J C Litherland, P M Taylor and S Evans
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High-resolution CT appearances of bronchiectasis are well described in the literature. We have noted areas of low attenuation occurring within the lung in some patients with bronchiectasis. The aim of this retrospective study was to assess whether there was any relationship between this finding and the clinical and physiological status of the patient. High-resolution CT images of patients with bronchiectasis scanned over a 4-year period were assessed by two radiologists. The presence or absence of low attenuation was assessed, along with the distribution and severity of bronchiectatic change. The patients' medical histories, smoking habits, lung function tests and immunoglobulin levels were abstracted from the notes. Patients with previous lobectomy, generalized emphysema and lobar collapse were excluded. 50 patients were reviewed and 26 (11 males and 15 females) were found to have low attenuation areas. No significant difference could be identified between the groups in respect of smoking histories, age, extent of disease, pulmonary function or immunoglobulin status. The aetiology of these abnormalities remains uncertain, although different mechanisms may be postulated. Our findings suggest that they may not be clinically significant.

3.16 – 3.24 pm

Aspergillus infection of the respiratory tract in patients with lung transplantation [Paper]

S Diederich, M Scadeng, C D R Flower, S Steward and C Dennis

Departments of Radiology, Pathology and Transplant Unit, Papworth Hospital, Papworth Everard, Cambridge CB3 8RE, UK

Chest radiographs (CXR), computed tomographic (CT) scans and records were analysed in 31 lung transplant patients with aspergillus infection (AI) of the respiratory tract diagnosed by culture (23/31) or transbronchial biopsy (TBB) (8/31). The first, most and, if possible, last abnormal CXR and all CT scans, related to an episode of AI, were reviewed by three readers. In 14/31 patients no pulmonary consolidation was demonstrated. With one exception, AI had been diagnosed in these patients by culture only. In 5/31 patients pulmonary consolidation could not be attributed to AI with certainty in the presence of other causes of consolidation. In 12/31 patients invasive pulmonary aspergillosis (IPA) was diagnosed by TBB ($n = 7$) or culture in the absence of other causes of consolidation ($n = 5$). Radiological findings in these patients included patchy consolidation (11/12), involving predominantly (11/12) the upper lung zones. In 7/12 patients there were also ill-defined nodules. There was initially rapid progression of the infiltration, within days. Resolution, typically, took several weeks. Awareness of the typical radiological appearances of AI may facilitate adequate therapy of this potentially life-threatening condition.

3.24 – 3.28 pm

The differential diagnosis and discriminatory features of circumferential pleural rind on computed tomography (CT) [Poster]

A P Richards and R J H Robertson

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Circumferential pleural thickening, or pleural rind, is a common manifestation of malignant mesothelioma and is said to be always indicative of malignancy. It was our impression that other malignant neoplasms could produce similar appearances. The aims of the study were: first, to determine a differential diagnosis for pleural rind; and second, to evaluate individual discriminant features for differing histological diagnoses. We reviewed 45 cases of histologically proven neoplasia showing pleural rind on CT. The majority of these are mesotheliomas, but a wide range of other diagnoses, including lymphoma, thymoma, squamous cell carcinoma, transitional cell carcinoma and sarcoma, are also reviewed. Discriminators studied include pleural calcification, effusion, mediastinal lymphadenopathy, chest wall invasion, mediastinal invasion and diaphragmatic/infradiaphragmatic invasion. A variety of malignant tumours may simulate the CT appearances of malignant mesothelioma. Biopsy is often unnecessary when dissemination of carcinoma is present, but remains important when pleural abnormality is a presenting feature.

3.28 – 3.32 pm

Asymmetrical film–screen combinations — a new light on the chest? [Poster]

R Keal, C Reek and C Smith

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Conventional film–screen combinations for chest radiography utilize matched pairs of screen and emulsions. Recent developments (Insight—Kodak, Highlight—3M) however, use different sensitivity and resolution screens and different contrast emulsions. This, combined with a zero crossover film base, allows two separate images to be displayed on one radiograph. We have investigated these film–screen combinations both objectively and subjectively. Despite the fact that traditional densitometry does not directly apply to this type of film, objective testing shows that they demonstrate a greater range of densities than conventional film. Subjectively, we have examined the image quality compared to conventional images and in relation to its clinical usefulness. The drawbacks are the increased cost of the film and the need to ensure correct orientation of the film to the screens. We present the results of our testing and comparison with conventional film–screen combinations. There are small but significant differences between the two systems tested. We conclude that the new film screen combinations are a significant advance over conventional images and that the extra cost is justified.

3.32 – 3.40 pm

Comparison of a new asymmetric film screen combination with conventional film in ITU chest radiography [Paper]

D Kessel, G T Rottenberg, C M Allen, P Maggs and M J Raphael

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We evaluated the usefulness of an asymmetric film screen system incorporating a flexible collimation grid (InSight,

Kodak Eastman) in mobile chest radiography of ITU patients. Conventional and InSight radiographs were taken post-operatively in 50 patients on admission to ITU. The paired images were assessed by the ITU staff and the reporting radiologists each recorded their preference. Subsequently, identifying markings were removed from the films. The films were then jointly reviewed in random order by two radiologists. Six (12%) of the conventional radiographs warranted repeating due to incorrect exposure; the ITU staff would have requested a further two repeats. All InSight films were of diagnostic quality. ITU staff and radiologists found InSight films contained more information and were easier to interpret. Mediastinal detail, endotracheal tube position, retrocardiac and retrodiaphragmatic lung were more readily assessed, but low opacity central lines were not so well seen on InSight films. The use of the InSight system results in improved quality of ITU chest radiography with reduced repeat rates.

3.40 – 3.48 pm

The role of cine magnetic imaging in the thorax [Paper]

C A Roobottom, D Scott and P Goddard

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The use of the Turbo Flash sequence on the Siemens 1 Tesla Magnetom magnetic resonance scanner allows the acquisition of ten separate images over a 19 s period. These can be viewed as a cine loop giving an appreciation of movement of individual mediastinal structures and the changes of lung volume over a single respiratory cycle. We have found this sequence useful in a number of situations in the chest, particularly in the assessment of phrenic nerve paralysis, large pleural effusions and large emphysematous bullae. Examples of cine loop images will be presented and their place in magnetic resonance imaging of the chest will be discussed.

2.15 – 3.59 pm

Interventional Radiology

Harewood Suite II

2.15 – 2.23 pm

Percutaneous drainage of mediastinal abscesses and fluid collections [Paper]

R A Morgan, E Wallser, G R Wittich and E van Sonnenberg
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Needle aspiration and catheter drainage of mediastinal fluid collections may be technically challenging due to the anatomical proximity of vascular structures. We discuss technical aspects and clinical results in 44 patients who underwent CT-guided needle aspiration of mediastinal fluid collections. Infected or symptomatic collections were treated with percutaneous insertion of catheters. We reviewed their medical records retrospectively. The aetiology of abnormal mediastinal fluid collections included oesophageal/anastomotic leaks (16 patients), prior cardiac surgery (nine), mediastinal pseudocysts (four), other abscesses (five), infected tumours (three), and non-infected cystic lesions (seven). Needle aspirations were performed in 12 patients. Catheter drainage was successful in 29 of 32 patients (90%). All procedures were performed under CT guidance. Anterior parasternal, posterior paravertebral, subxyphoid, and jugular fossa access routes were used. Failures included predominantly phlegmonous collections. There were no significant complications. We concluded that CT-guided aspiration and drainage of mediastinal fluid collections is safe and effective. The vast majority of patients with abscesses can be cured percutaneously.

2.23– 2.31 pm

Transgluteal drainage of pelvic fluid collections: a traditional and effective alternative to newer percutaneous transvaginal and transrectal approaches [Paper]

G W Boland, M J Lee, P R Mueller and J Gaa
Department of Radiology, Massachusetts General Hospital, Boston MA 02114, USA

Transvaginal and transrectal approaches to deep pelvic collections have recently been advocated. We reviewed 52 patients with pelvic collections drained transgluteally, to document the safety and efficacy of this traditional alternative to newer approaches. The patients were aged from 3 to 89 years (mean 53.4) and underwent CT-guided transgluteal drainage of deep pelvic collections. 20 collections were multilocular. Trocar technique was used for drainage in 45/52 (87%), Seldinger in 7/52 (13%). Pelvic fluid collections were successfully drained in 46/52 patients (88%). 10/52 (20%) of cases demonstrated communication with bowel or bladder; 8/10 were successfully drained. Three patients with necrotic tumours were temporized by catheter drainage until their death. Failures, requiring surgery for cure, occurred in three patients: two with multilocular collections and one with Crohn's disease. Duration of drainage was between 2 and 28 days (mean 8 days). Catheter size ranged from 8F to 16F. Catheter dislocation, requiring catheter replacement, occurred in four patients. Two patients required tube changes because of inadequate drainage. Only two patients experienced temporary leg pain. No sciatic nerve injury or persistent sequelae occurred. Transgluteal drainage remains an effective percutaneous therapy for pelvic collections. Advantages over newer approaches include the ability to insert larger catheters or multiple catheters, particularly for multilocular collections; catheters are less likely to be dislodged.

2.31 – 2.35 pm

Percutaneous biopsy of gastric lesions [Poster]

C Jones, D West, S Peterson, C Yeong and M R Rees
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It has previously been thought that percutaneous biopsy of gastrointestinal lesions was not appropriate because of the risk of the bowel contents leaking into the peritoneal cavity, together with the potential risk of seeding along the needle tract. The use of fine needle aspiration considerably reduces the risk of peritoneal leakage. Two cases of diagnosis of gastric carcinoma by percutaneous fine needle aspiration are reported; in both cases repeated endoscopic biopsy failed to make a positive diagnosis. A 76-year-old man with a history of epigastric pain had a barium meal which demonstrated an ulcer with malignant features on the lesser

curve of the stomach. Two upper gastrointestinal endoscopies with multiple biopsies failed to make a positive diagnosis; however, percutaneous biopsy under X-ray screening control with the stomach coated with contrast medium yielded histological evidence of adenocarcinoma. A 50-year-old man with a history of dysphagia underwent an endoscopy which demonstrated a malignant-looking, lesion in the cardia; multiple biopsies only demonstrated dysplasia. A barium meal and CT scan both indicated possible malignancy. Three further endoscopies with multiple biopsies failed to confirm the presence of a carcinoma. Percutaneous biopsy was performed under ultrasound control and confirmed the presence of an adenocarcinoma. In neither case were there any complications arising from the biopsy. We conclude that percutaneous biopsy of gastric lesions is feasible and a potential alternative to endoscopic biopsy.

2.35 – 2.43 pm

Ultrasound-guided renal biopsy — closing the audit loop, and a caveat [Paper]

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Departments of [1]Radiology and [2]Renal Medicine, Royal Infirmary of Edinburgh, Lauriston Place, Edinburgh EH3 9YW, UK

The purpose was to audit the introduction of the practice of radiology registrars performing renal biopsies utilizing an 18G needle and Biopty gun under real-time ultrasound guidance · procedures formerly performed by a single consultant radiologist utilizing the same technique. We carried out a retrospective review of 100 consecutive biopsies, 60% performed by radiology registrars; the results were compared with those of the preceding 101 biopsies. A diagnostic specimen was retrieved in 91% of biopsies (renal tissue obtained in 99%). Overall, complications occurred in 10% of biopsies. Four of these were significant (haemorrhagic) complications, compared to the single occurrence in the preceding series ($\chi^2 = 2.33$, not significant). Each of these more serious complications in this series occurred whilst using a 2 cm travel Biopty gun rather than the original 1.1 cm travel Biopty gun ($\chi^2 = 4.56$, $p < 0.05$). The mean length of hospital stay for elective biopsies has remained short with the Biopty device: 1.56 nights (95% CI 1.42–1.70). It is clear that by using this method, radiologists without previous experience in ultrasound-guided biopsy can successfully obtain renal biopsies without significantly increasing complications. The 2 cm travel Biopty device should not be used due to the higher incidence of significant complications.

2.43 – 2.51 pm

Laser guidance system for CT-guided procedures [Paper]

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Departments of [1]Radiology and [2]Surgery, Hôpital Saint-Louis, Paris 75010, France

We describe a simple CT guidance system using a laser linear beam mounted on the CT gantry without need of additional software or any component needing to be sterilized or to be mounted beside the CT scanner. A protractor is mounted on an horizontal rail fixed on top of the gantry and is designed to be able to slide along the length of the rail. The protractor supports a laser beam which can rotate about the centre of the protractor while always remaining in the plane of the gantry. Once the gantry is tilted, the device moves with it, allowing compound angulation of the biopsy path. Once the skin entry point and the angulation of the target path are determined from the software program provided by the CT manufacturer, the system can project the needle direction. 15 patients underwent percutaneous localization of pulmonary nodules (size 5–20 mm) with a hooked wire for thoracoscopic lung resection. Localizations were accurate within 4 5 mm of the predetermined target point. This device allows precise placement of needles in even small lesions, with very few needle manipulations or localization scans.

2.51 – 2.55 pm

CT guided percutaneous needle biopsies — contribution to histological diagnosis [Poster]

G Walsh and M P Williams

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We reviewed the results of 150 percutaneous needle biopsies obtained under CT guidance, 22 from liver, 15 from bone, 30 from lung/pleura, 20 from retroperitoneum, 22 from pancreas, 15 from pelvis and 26 others. Specimens were obtained using the Biopty gun in 72% of cases; bone biopsies were performed with 11 G Islam needles and fine needle aspirates were obtained from pancreas and lung. Patients' ages ranged from 40 to 81 years (mean 60 years). Results from retroperitoneal biopsies were very encouraging, with diagnostic histology obtained in all cases. In addition, these specimens were adequate for classification in cases of retroperitoneal lymphoma. Biopsies taken from bone, pleura/lung and intrahepatic lesions also provided diagnostic histology in over 90% of cases. The greatest difficulty has been encountered in obtaining satisfactory specimens from the pancreas. We have found fine needle aspirates to be of diagnostic value in only 50% of cases. This low yield we attribute to a combination of specimen

inadequacy and geographical misses. In recent months, pancreatic specimens have been obtained with the larger 18 G needle in the biopty gun. Our preliminary results with this technique are promising. In our experience CT guided percutaneous needle biopsy is a reliable, minimally invasive method of obtaining specimens adequate for accurate histological diagnosis.

2.55 – 2.59 pm

Percutaneous biopsy of osteolytic skull base lesions [Poster]

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Conventional surgical biopsy of oesteolytic skull-base lesions may be precluded by the site or vascularity of the lesion, or may be difficult if the site for biopsy cannot be precisely defined. Two such cases are described in which percutaneous techniques were used to obtain histological diagnosis. Both patients had developed progressive multiple cranial nerve palsies and investigation showed that each had an osteolytic lesion within the skull base. In the first case, CT-directed biopsy of a soft tissue mass in the body of the sphenoid was undertaken after previous attempts at "blind" surgical biopsy had been inconclusive. In the second case, histological diagnosis of an extensive and highly vascular skull-base tumour was obtained following transvenous biopsy. The abnormalities and biopsy techniques employed are described. These cases illustrate how techniques of percutaneous biopsy, established in other clinical areas, may be successfully employed by neuroradiologists.

2.59 – 3.07 pm

Coronary angioplasty using 6F guiding catheters [Paper]

M R Rees and L K Michalis
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We wished to determine whether routine use of 6 French guiding catheters for coronary angioplasty is feasible. 50 consecutive patients undergoing coronary angioplasty were enrolled in the study. Prior to angioplasty, the patients' angiograms were assessed to see whether it would be necessary to use alternative angioplasty techniques, requiring the placement of an 8F sheath or larger, or whether a stent was likely to be required. On this basis 19 patients were treated using 8F catheters and the remaining 31 were treated using 6F catheters. In the 31 patients selected for 6F guiding catheters, all patients had a successful angioplasty without the need for a larger-lumen catheter. In total, 38 lesions were treated, using 26 monorail and 17 over-the-wire balloons. Vessel opacification was reduced in 21/31 procedures and was considered poor in 12/21 procedures. Groin haematoma was seen in 4/31 patients, with one patient having a post-angioplasty myocardial infarction. 24/31 patients were able to be mobilized early and discharged within 24 h of the angioplasty. We have demonstrated that coronary angioplasty using 6F guiding catheters is feasible, and can led to early discharge of the patient. It appears to be applicable in approximately 50% of patients requiring angioplasty. Two major drawbacks of this technique are the reduced opacification of the vessels and the limited access for bail-out procedures.

3.07 – 3.11 pm

Eye splashes during invasive radiological procedures [Poster]

I R Davidson, A J Crisp, D C Hinwood, S C Whitaker and R H S Gregson
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In recent years there has been an increased awareness among health care workers of the possibility of nosocomial transmission of blood-borne pathogens. The aim of this study is to document the risk of contamination of radiologists' eyes during invasive vascular procedures by potentially infected material. 150 such procedures were assessed prospectively in order to establish the frequency of eye splashes and spray events. Radiologists performing these examinations were asked to wear glasses throughout. After each examination the glasses were inspected for droplets of blood or potentially infected material. 150 procedures were performed on 123 patients (M = 80, F = 40). 10 procedures (6.7%) resulted in splashes to glasses. In four of these cases the radiologist was not aware of the "eye splash" nor was there a spray event to account for it. Radiologists were aware of 13 spray events (8.6% of all procedures) which accounted for six of the eye splash events. The number of eye splashes found on the glasses ranged from 1 to 10 (mean 3.3). Those radiologists not used to wearing glasses complained that they were uncomfortable in 88% of the procedures they performed. One radiologist found that the glasses interfered with the procedure and removed them in two out of 25 cases he performed. There were no needle stick injuries during this study. Eye splashes are a frequent occurrence during arteriography and radiologists are not always aware of eye splashes when they occur. It is suggested that protective eye wear should be used routinely during invasive vascular procedures.

3.11 – 3.15 pm

Resection of retained valve cusps in an *in situ* vein graft with the Simpson Atherocath [Poster]

J Walker, N Chalmers and I N Gillespie
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Peripheral arthrectomy was developed to remove atherosclerotic plaque from diseased arteries but has found several other applications. We describe a further one, namely the resection of retained valve cusps in *in situ* vein grafts. A patient presented with an occlusion of her *in situ* saphenous vein graft. Thrombus was present in the distal portion. Aspiration thrombectomy revealed an underlying tight stenosis, thought to be a valve cusp. This was successfully angioplastied. However 11 months later the graft reoccluded. As before, thrombus was removed, revealing the stenosing cusps. Atherectomy was performed, resulting in good flow. The retrieved fragments from the Atherocath were confirmed to be valve cusp on pathological examination. 3 months afterwards, the graft remains patent. We suggest that angioplasty may produce improvement in the lumen but that the stenosis may recur because the valve cusps are retained. Atherectomy has the advantage of excising the valve cusps, possibly resulting in improved long-term patency.

3.15 – 3.23 pm

Myocardial ischaemia during peripheral angioplasty: association with hypertension and hypoxaemia [Paper]

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The incidence of silent myocardial ischaemia correlates with adverse postoperative cardiac events in patients undergoing peripheral arterial surgery. This study aimed to detect silent ischaemic episodes in patients undergoing peripheral vascular angioplasty and identify any relationship to hypoxaemia, hypertension, tachycardia and angioplasty balloon inflation. 29 unsedated patients underwent simultaneous monitoring of ECG, SpO_2, and non-invasive arterial blood pressure. Group 1 received oxygen 4 l min^{-1} by facemask during the procedure. Patients in Group 2 breathed air. The distribution of myocardial risk factors between the two groups was similar. Five of 17 patients in Group 2 had silent ischaemic episodes compared with one of 12 patients in Group 1 ($p = 0.08$). Eight patients in Group 2 had episodes of $SpO_2 \leqslant 90\%$. SpO_2 in Group 1 patients was always $> 90\%$. The duration of the silent ischaemic episodes correlated with the length of time $SpO_2 \leqslant 90\%$ ($p < 0.001$), and the maximum systolic blood pressure ($p < 0.001$). Silent myocardial ischaemic events occurred, related to hypertension and hypoxaemia. There was a high incidence of hypoxaemia in the group of patients breathing air during the procedure. In this study, administration of oxygen abolished hypoxaemia and may reduce silent ischaemia.

3.23 – 3.27 pm

Use of the Simpson's atherectomy catheter for treatment of a prolapsed intimal flap raised after angioplasty [Poster]

D E Roberts and D A Gould
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We describe the use of a Simpson's atherectomy catheter to resect an intimal flap raised after angioplasty. A 66-year-old man presented with Grade IV peripheral vascular disease. Aortofemoral arteriography demonstrated an 8 cm occlusion in the distal left superficial femoral/proximal popliteal artery. An angioplasty was performed and post-angioplasty angiograms showed a short occlusion in the mid-popliteal region with patency in the previous occlusion. Thrombolysis and suction thromboembolectomy were unsuccessful in resolving the situation. It was thought that this might represent a raised intimal flap. A Simpson's atherectomy catheter was used to resect the lesion. Histology of the resected specimen confirmed presence of atherosclerotic plaque and intima.

3.27 – 3.31 pm

Arteriovenous fistulae occurring after renal transplantation kidney biopsy: treatment [Poster]

D W White, P C Rowlands and R D Edwards
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Arteriovenous fistula is a known complication following renal biopsy. The incidence varies from 15 to 18% in the native kidney and is 2% in the transplanted kidney. These may heal spontaneously but may present clinically. In the past treatment has been either conservative or by surgery. Embolization is now being used in the management of arteriovenous fistulae in the transplanted kidney. We describe four cases of post-biopsy arteriovenous fistulae and their successful treatment using embolization coils placed via the arterial approach.

3.31 – 3.39 pm
Percutaneous angioplasty of dialysis fistulae to maintain vascular access [Paper]
S Gurney and R Ashleigh
Department of Radiology, Withington Hospital, Manchester M20 8LR, UK

Dialysis patients may require treatment for many years. Sites for fistula formation are limited, making maintenance of each individual site crucial. Venous stenoses due to intimal fibromuscular hyperplasia are a common reason for fistula failure. Surgical fistula salvage has the disadvantage of requiring several weeks of alternative access, whereas for percutaneous angioplasty the patient can attend by the day, with dialysis able to resume within 24 h. Patients are referred on clinical grounds. Falling flow rates, reduced thrill and difficulty in needling are the main indications. Between January 1991 and July 1993, fistulograms on 10 patients revealed stenoses of the main draining vein. Angioplasty is performed under local anaesthetic with sedation and analgesia as required. Local anaesthetic is instilled at the site of dilatation, as well as the puncture site. A 3000 μ heparin bolus is given just prior to dilatation, which is performed with a high pressure balloon (15 atm), using long inflation times (5 min). Topical GTN is applied after the procedure to reduce vascular spasm. Initial success of 90% with 6-month patency of 80% compares with other published series. Percutaneous angioplasty of fistulae is successful in maintaining vascular access in dialysis patients, with minimum disturbance of their haemodialysis programme.

3.39 – 3.43 pm
Pelvic arterial embolization following hysterectomy and bilateral internal iliac artery ligation for intractable primary post-partum haemorrhage [Poster]
C D Collins and J E Jackson
Department of Diagnostic Radiology, Hammersmith Hospital, London W12 0NN, UK

Intractable primary post-partum haemorrhage has an incidence of 5 to 10% and is most often treated by hysterectomy and bilateral iliac artery ligation if required. This form of surgery is however not without its difficulties and is associated with a best success rate of 40%, mainly due to the presence of an extensive collateral circulation within the pelvis. Angiographic arterial embolization is a viable alternative procedure. The aim of this presentation is to demonstrate that prior surgical ligation of the internal iliac arteries does not necessarily preclude successful arterial embolization and to demonstrate our technique when this situation is present. The need for early radiological intervention is highlighted and the advantages of this approach discussed.

3.43 – 3.51 pm
Transjugular intrahepatic portosystemic shunts (TIPSS): results after 2 years [Paper]
J D G Rose, M Hudson, A Turnbull, O F W James and M F Bassendine
Departments of Radiology and Medicine, Freeman Hospital, Newcastle upon Tyne NE7 7DN, UK

The insertion of TIPSS was evaluated in 33 consecutive patients with acute or recurrent variceal bleeding ($n = 21$, five with associated portal gastropathy and two with colopathy), resistant ascites ($n = 11$) and preoperative portal decompression ($n = 1$). All 33 patients had underlying cirrhosis (21 alcohol, seven PBC, two HB/C virus, three cryptogenic), one of whom had superimposed HCC; 3/33 had occluded portal vein, one of which was due to neoplastic infiltration. All patients were reassessed by portal venography 3–6 months and 12 months after the procedure. TIPSS were completed in 30/33 patients with no procedure-related deaths. The mean portosystemic pressure gradient was reduced to 11 mm Hg (range 6–20). Complications included four cases of worsening renal failure and two of deteriorating hepatocellular function. In the group with variceal bleeding, 19/21 patients have had no further admissions with bleeding after TIPSS. Both recurrent bleeds were associated with stent stenosis at 8 and 9 months. Of the 33 patients, five have undergone liver transplantation, five have died, and the remainder have survived an average of 5.3 months (range 1–16). We conclude that TIPSS is effective in lowering portal pressure and thus controlling variceal bleeding, portal colopathy and resistant ascites. Our experience would suggest that stents should be directly imaged at 3 months to prevent subsequent complications.

3.51 – 3.59 pm
Percutaneous aspiration thromboembolectomy (PAT) — a preliminary experience [Paper]
J G Murray, A L Brown and R A Wilkins
Department of Diagnostic Imaging, Northwick Park Hospital, Harrow HA1 3UJ, UK

Percutaneous aspiration thromboembolectomy (PAT) is a radiological alternative to surgical embolectomy or thrombolysis in the treatment of acute arterial thromboembolic disease. We present our experience of its use in eight patients over a 2-year period. Patients were aged from 63 to 83 years (mean 71 years). Indications were graft thrombosis (one), or emboli from atrial fibrillation (three), abdominal aneurysm (two) or proximal angioplasty (two). PAT was

performed at 10 arterial sites: common iliac (one), profunda femora (one), superficial femoral artery (two), popliteal artery (two) and arteries of trifurcation (three). PAT was used as an adjunct to thrombolysis or angioplasty in five patients and as the sole procedure in three patients. It was successful at seven sites, with mean ABI rising from 0.4 before the procedure to 0.8 afterwards. Two of the failures required amputations. One of these was a completely thrombosed Dacron femoral-popliteal graft with poor run-off; the second had a failed surgical embolectomy prior to amputation. There were no major complications, and no morbidity on follow-up at 1 month. PAT is a useful adjunct to thrombolysis and balloon angioplasty in the radiological treatment of acute thromboembolic disease. In patients in whom thrombolysis is contraindicated, it offers an alternative to surgical embolectomy.

2.15 – 3.36 pm

Body Composition & Tissue Characterization

Bramham Suite

2.15 – 2.40 pm
Bone densitometry — use and misuse [Invited Review]
S Pors Nielsen and O Bärenholdt
Department of Diagnostic Imaging, Hillerød Hospital, DK-3400 Hillerød, Denmark

The following will be discussed in this review lecture on DXA for bone densitometry: (1) precision; (2) accuracy; (3) measuring sites; (4) interpretation of measured BMC (g) and projected areal density BMD ($g\,cm^{-2}$); and (5) correction for differences in body size and bone size. Good reproducibility (precision error of less than 1%) is essential for monitoring longitudinal changes in one individual. Good accuracy is mandatory for a correct diagnosis of osteopenia and fracture risk evaluation. Extrapolation of measured values to other skeletal sites or the whole skeleton is problematic. At least two measuring sites are necessary, e.g. lumbar spine and femoral neck. BMC is highly dependent on bone size, as is BMD although to a lesser extent. BMC and BMD fracture risk limits should be used with caution, unless correction for differences in bone size is done. It appears from logistic regression analysis that lumbar spine BMC should be corrected by dividing measured BMC with $(\text{vertebral diameter})^{1.5}$. $(\text{height at menopause})^{1.5}$, when identification of fracture risk patients is the problem. Purchase price and running costs of modern scanning DXA equipment are not immaterial. We have developed an inexpensive, mobile, compact, non-scanning DXA device for instant imaging and rapid calculations on a PC, based on a cooled astronomical type CCD detector. Results from the first prototype are promising. Access to rapid, correct, inexpensive osteodensitometry is a prerequisite for common use and would help make it easier to identify post-menopausal women needing oestrogen/progestin replacement therapy.

2.40 – 2.48 pm
Validation of a technique to measure hand bone mass using dual X-ray absorptiometry [Paper]
J Lilley, J Devlin, S Eyre, A Gough and P Emery
Department of Medical Physics, Queen Elizabeth Hospital, Birmingham B15 2TH, UK

Dual X-ray absorptiometry (DXA) provides a precise measure of bone mineral content (BMC). New software developed by Lunar RC was used for the first time for measurements of the human hand. *In vitro* precision was assessed using multiple scans of a male cadaver hand. The coefficient of variation varied from 1.0 to 0.6% for BMC according to the duration of scan (6–40 min). For the entire hand region BMC varied with scan speed and resolution from 32.9 to 40.2 g. *In vivo* precision was measured on four volunteers using a resolution of 1.2×2.4 mm and a scan time of about 10 min. Precisions were 1.6%, 3.9% and 2.9% for BMC at the hand, MCP and CMC, respectively. The effect of hand deformity was examined in three volunteers, scanned three times with the hand in different degrees of flexion. The maximum error detected was 5% for the hand, representing an acceptable level of variation. Thus BMC of the entire hand and selected areas can be measured precisely. This allows the objective assessment of early RA patients at a time when there is no quantitative change on plain radiographs.

2.48 – 2.56 pm
The *in vivo* measurement of bone aluminium by neutron activation analysis [Paper]
J Evans, S Green and G Lipkin
Department of Medical Physics, Queen Elizabeth Hospital, Birmingham B15 2TH, UK

Renal dialysis patients have been found to be particularly at risk from diseases associated with aluminium accumulation. Consequently there exists a need to measure and monitor the amount of aluminium in the body as an assessment of this risk. The potential of neutron activation analysis as a non-invasive technique to measure partial body aluminium has been demonstrated in a few centres, and an accelerator-based system is currently being developed in Birmingham. This particular facility is expected to relieve many of the problems previously encountered by using alternative neutron sources. The present minimum detection limit of 3 mg for a delivered effective dose equivalent of less than 0.1 mSv should enable the amount of aluminium in the hand of a normal individual to be detected, and reliable measurements to be made of the raised levels expected in renal dialysis patients. The

neutron transport of the Birmingham system is being modelled by Monte Carlo code and the benefits derived from this will be discussed in terms of further system improvements. A protocol for a clinical study involving up to 100 patients has been approved by ARSAC, and it is expected that some initial results from this study will be presented.

2.56 – 3.04 pm
Measurement of body composition using dual energy X-ray absoptiometry: comparison with total body potassium, skinfold anthropometry and bielectrical impedance in health and disease [Paper]
M A Smith, B Oldroyd, S Stewart, F Roman, P Bramley, R Milner, M Simpson, J Truscott, C Westmacott and M Losowsky
Centre for Bone and Body Composition Research, University of Leeds, Leeds General Infirmary and St James Hospital, Leeds, UK

A group of 71 controls (30 male and 41 female) and 55 patients (22 male and 33 female) with liver cirrhosis have been studied. The following measurements were made on all subjects. Percentage fat and lean body mass were measured using dual energy X-ray absoptiometry (DEXA), estimates of muscle mass were obtained using total body potassium, percentage fat was estimated using skinfold anthropometry and bielectrical impedance, both whole body and segmental, was used to measure total water from which percentage fat and fat free mass estimates were derived. The validity of the various methods and the use of a derived four compartment model will be presented.

3.04 – 3.12 pm
MR texture analysis [Paper]
D W M Boyce and K Straughan
MagNET, Imperial College, London SW7 2BT, UK

The superb, controllable soft-tissue contrast achievable by MR has brought with it the hope for improved *in vivo* characterization. Relaxometry has yet to deliver its hoped-for tissue characteristic potential. Functional imaging, diffusion mapping and other emerging strategies all offer new potential. However, recent work has demonstrated the value of post-processing conventional MR images to enhance their tissue characteristic potential. The approach to be described in this paper is that of statistical texture analysis. The wide-ranging study reported here has applied most of the conventional statistical texture analytic tools plus some novel developments (including transform and fractal methods) to some interesting clinical MR problems. The texture tools have been used to create a highly dimensioned feature-space representation of the image features, which is then the subject of a classifier. Significant numbers of well-defined images have been analysed in this way. The paper presents examples of the results obtained from the various texture tools for a number of clinical scenarios. The relative merits of the various techniques are identified and some of the pixel-number based limitations of the statistical approach are explored. MR texture analysis is confirmed as a useful diagnostic tool and its future potential is explored.

3.12 – 3.20 pm
Application of Hankel singular value decomposition (HSVD) to *in vivo* localized H1 spectra from patients with schizophrenia [Paper]
J MacEnri, P Gilligan, C M Moore, O M Redmond and J T Ennis
Institute of Radiological Sciences, University College Dublin, 52 Eccles Street, Dublin 7, Ireland

We set out to evaluate the usefulness of HSVD, an automated non-interactive time domain spectral quantification technique, in analysis of localized H1 spectra from patients with schizophrenia and from a suitable age-matched control group of healthy volunteers. The spectra were obtained using a Siemens Magnetom 1.5 T whole body MR scanner with the STEAM localized proton spectroscopy sequence. An implementation of the HSVD was used to analyse the spectra. The resulting calculated parameters and the time domain signals were then transferred to an IBM PC compatible computer for determination of peak areas and relative metabolite ratios. These results were compared to those previously estimated using a manual integration method. The results obtained by the HSVD method did not correlate well with those obtained previously by manual integration. The low signal-to-noise ratio, narrow bandwidth and complexity of *in vivo* H1 NMR spectra cause wider standard deviations in the automatic estimation of the metabolite ratios by HSVD. We conclude that HSVD is not applicable to the type of *in vivo* spectra obtained in this study.

3.20 – 3.28 pm
Quantification of the human quadriceps muscle using MRI and stereological image analysis techniques [Paper]
[1]J M Walton, [2]N Roberts, [2]G H Whitehouse and [2]R H T Edwards
[1]Department of Diagnostic Radiography and [2]Magnetic Resonance Research Centre, University of Liverpool, Liverpool L69 3BX, UK

Quantification of the cross-sectional area of the quadriceps muscle at a particular anatomical level, or its overall

volume, is useful for monitoring muscle weakness, atrophy or hypertrophy resulting from trauma or disease. We do not know how much traditional methods of image measurement, including planimetry, may be biased. Stereology permits unbiased estimates of cross-sectional area and volume to be obtained with known precision. This study describes the method for the unbiased quantification of the quadriceps muscle using magnetic resonance imaging and computer-assisted point counting. 27 parallel axial sections were acquired through the left quadriceps muscle of a single subject. The cross-sectional area of the muscle at each level was estimated by point counting. Subsequently, Cavalieri's method was applied to estimate muscle volume. Error analysis was performed, and nomograms derived for the convenient assessment of the number of sections required to achieve a known coefficient of error on the volume estimate, and also the contribution to point counting. The nomograms may be referred to for optimization of the sampling design for the quantification of the quadriceps muscle and other skeletal muscles of similar shape.

3.28 – 3.36 pm

Comparison of ultrasound and MRI in the quantification of the quadriceps muscle by stereology [Paper]

[1]J M Walton, [2]N Roberts, [2]G H Whitehouse and [2]R H T Edwards

[1]Department of Diagnostic Radiography and [2]Magnetic Resonance Research Centre, University of Liverpool, Liverpool L69 3BX, UK

Morphometry is valuable for monitoring changes in muscle cross-sectional area and volume resulting from disease and trauma. Ultrasound and MRI may both be applied to the direct, *in vivo* study of human skeletal muscle. MRI is widely recognized as the premier imaging modality for the quantification of muscle. The operator dependence of ultrasound is likely to influence its accuracy and repeatability. This study compares results from the application of unbiased methods for the estimation of cross-sectional area and volume of the quadriceps using both imaging modalities. Ten subjects participated in the study. The cross-sectional area of the muscle was estimated at the junction of the proximal one-third and distal two-thirds of the left thigh. Seven sections of the left thigh were obtained for the estimation of muscle volume by Cavalieri's method. Point counting was used to quantify muscle area and volume. There was good agreement between the two methods described, all estimates being within the range of ± 2 standard deviations ($n = 10$) of the mean difference between methods. The ultrasound technique is less expensive and when optimally applied may be a reliable alternative to MRI for muscle quantification.

2.15 – 3.56 pm

Radiobiology: Photodynamic Therapy

Charter Suite

2.15 – 2.40 pm
Photodynamic therapy [Invited Review]
F A Stewart
Department of Experimental Therapy, The Netherlands Cancer Institute, Amsterdam 1066 CX, The Netherlands

Photodynamic therapy (PDT) is an experimental modality for the treatment of small tumours where adequate local surgery is difficult (*e.g.* bronchus, oesophagus, bladder). Selective cancer destruction is achieved by local illumination of the tumour area after systemic administration of a photosensitizer. Cell killing requires the presence of oxygen and is mediated through the production of singlet oxygen and free radicals when light of a suitable wavelength interacts with the sensitizer. One of the major effects of PDT *in vivo* is the induction of local hypoxia due to endothelial cell damage and vascular occlusion. Much of the cell kill achieved in solid tumours is a secondary consequence of PDT induced vascular damage and ischaemia. Experimental studies have demonstrated that it is possible to exploit this induced hypoxia by giving a bioreductive drug (which requires metabolic reduction to become toxic) prior to illumination. The drug is activated in the hypoxic conditions created by the PDT, leading to enhanced tumour cell kill. The photosensitizer which has been most extensively tested, Photofrin, has a number of drawbacks for clinical PDT. It is a mixture of monomeric, dimeric and oligomeric species, with only a small absorption peak in the red region of the spectrum (630 nm). Photofrin is also retained in the skin for many weeks, leading to protracted skin photosensitivity. New photosensitizers are being developed which have strong absorption peaks (efficient photosensitization) at longer wavelengths (better light penetration in tissue) and which are rapidly cleared from skin (reduced skin phototoxicity).

2.40 – 2.48 pm
Preclinical evaluation of R and S isomers of RB6145, a hypoxic cell radiosensitizer and cytotoxin [Paper]
[1]S Cole, [1]I J Stratford, [1]G E Adams, [2]J S Sebolt-Leopold and [2]H D Showalter
[1]Experimental Oncology Division, MRC Radiobiology Unit, Chilton, Didcot OX11 0RD, UK and [2]Parke-Davis Pharmaceutical Research, Warner Lambert Co., Ann Arbor, MI 48103, USA

RB6145, which is a pro-drug of RSU1069, is a potent hypoxic cell radiosensitizer and bioreductively-activated cytotoxin. RB6145 is a racemic mixture of an R isomer, PD144872, and an S isomer, PD144871. The effectiveness of these individual isomers and the racemic mixture (RB6145) as hypoxic cell cytotoxins was compared in three murine tumours (KHT, RIF-1, SCCVII) and two human tumour xenografts (HT29 colon adenocarcinoma, H647 lung adenosquamous carcinoma). Mice with approximately 100 mm^3 subcutaneous tumours were given each compound intravenously, in pH5 lactate buffer, at single doses up to and including the maximum tolerated dose (300 mg kg^{-1}). The effect of the agents on hypoxic cells was assessed by their use in combination with: firstly, local X-rays (10 Gy or 20 Gy); secondly, clamping the tumour vasculature to create a wholly hypoxic tumour. Measurements were made of tumour growth delay *in vivo* or of surviving fraction of clonogenic cells *in vitro*. All the results indicate that the racemate RB6145 and the R and S isomers are equally effective hypoxic cell cytotoxins. This is illustrated by the finding with H647 xenografts where drugs are used in combination with 90 min clamping. The following values give the time in days (mean $\pm$ S.E. (n)) for tumours to reach four times their volume at treatment: for untreated tumours 21.5 ± 2.3 (19), clamp alone 17.4 ± 1.7 (12), RB6145 + clamp 44.9 ± 3.4 (7), PD144872 + clamp 46.8 ± 4.7 (8) and PD144871 + clamp 41.9 ± 7.0 (9).

2.48 – 2.56 pm

Can magnetic resonance spectroscopy be used for determining the optimum time for treatment of tumours with photodynamic therapy combined with bioreductive drugs? [Paper]

[1]J C M Bremner, [1]J K Bradley, [1]I J Stratford, [2]S B Brown, [2]S R Wood and [1]G E Adams

[1]Experimental Oncology Division, MRC Radiobiology Unit, Chilton, Didcot OX11 0RD and [2]Department of Biochemistry and Molecular Biology, University of Leeds, Leeds LS2 9JT, UK

Photodynamic therapy (PDT) involving the systemic administration of a photosensitizer followed by the localized photo-irradiation of tumours can induce severe damage in some tumours. Such damage greatly increases the level of tumour hypoxia and creates an environment suitable for reductively activating bioreductive drugs. We have shown previously that the anti-tumour activity of the bioreductive drugs RSU 1069 and RB 6145 is greatly potentiated by PDT using the disulphonated aluminium phthalocyanine as the photosensitizing agent. The success of the combined treatment depends upon both the severity and the duration of the induced hypoxia. We have used real-time ^{31}P magnetic resonance spectroscopy (MRS) to follow changes in the kinetics of phosphorus metabolism occurring during, and immediately after, treatment of experimental murine tumours with PDT using novel phthalocyanines. Increase in tumour hypoxia is strongly suggested by observed increases in Pi (inorganic phosphate) and subsequent decreases in ATP. However, the rate and duration of these changes are highly dependent on the nature of the photosensitizer and its location within the tumours. We have also compared the changes in ^{31}P metabolism (expressed as the ratio of Pi/total phosphorus) with changes in tumour blood flow (determined by ^{2}H MRS) occurring after PDT using the different photosensitizers. Knowledge of the kinetics of these changes and their dependence on the nature of the photosensitizer should assist in the optimization of PDT treatments using bioreductive drugs.

2.56 – 3.04 pm

Light delivery and dosimetry in photodynamic therapy [Paper]

E J Hudson, M R Stringer and M A Smith

Department of Medical Physics, University of Leeds, Leeds LS1 3EX, UK

Photodynamic Therapy (PDT) is a cancer treatment that utilizes the combined effect of a localized photosensitizing agent and light illumination to yield cell death in targeted tissue. Our multidisciplinary approach is directed towards a better understanding of the processes involved in drug localization, the transmission of light in tissue and the production and dynamics of a transient cytotoxic species. In most treatments laser light is employed and is often delivered via a single optical fibre. The characteristics of fibre optic light delivery schemes will be described in terms of PDT requirements in areas such as the bronchus, oesophagus and uterus. A method of measurement of the *in vivo* light distribution during PDT and studies carried out upon *in vitro* tissue models that aid in the prescription of an effective light dose for subsequent treatments are presented. Over a period of 2 years more than 150 patients have been treated. The practical details of superficial, interstitial and internal laser light delivery to patients will be discussed.

3.04 – 3.12 pm

Interstitial laser photocoagulation of liver metastases: 5 years' experience [Paper]

C M Allen, Z Amin, F Laoudi, S Bown and W R Lees

Department of Radiology and National Medical Laser Centre, The Middlesex Hospital, London W1N 8AA, UK

We present our 5 years of clinical experience using interstitial laser photocoagulation (ILP) to treat liver metastases. 116 liver metastases have been treated in 45 patients. Between one and eight 0.2 mm optical fibres were inserted percutaneously into each tumour, using 19 gauge needles, under ultrasound guidance. 2W per fibre were delivered by a Nd:YAG laser for 400 s. Treatment effects were monitored in real time with ultrasound, and the extent of tumour necrosis evaluated 24 h later using dynamic CT. Thermal change, consisting of an irregular echogenic zone appearing around the tip of the laser fibre during ILP, was seen in all patients with ultrasound. Dynamic CT demonstrated the laser-induced necrosis as a new area of non-enhancement in the region of the metastases. Greater than 75% necrosis of tumour volume was achieved in 71% of patients treated and 100% necrosis in 21% of patients. Life survival analysis gave predicted 1- and 2-year survivals of 86% and 75%, respectively. ILP is a minimally invasive technique of *in situ* tumour destruction. It offers a minimally invasive alternative to major surgery in patients with small liver metastases, and a mechanism of debulking tumour in patients with large-volume disease.

3.12 – 3.20 pm

Angiogenesis in breast tumour — pre-pathological diagnosis using functional dynamic imaging [Paper]

F Flanagan, P Gilligan, J Stack, J Costello, P Dervan and J Ennis

Department of Radiology, University College of Dublin, Institute of Radiological Sciences, Mater Misericordiae Hospital, 52 Eccles Street, Dublin 7, Ireland

New vessel formation (angiogenesis) may be an important diagnostic parameter in tumours with a metastatic potential. This study evaluates the accuracy of functional dynamic imaging techniques in predicting tumour angiogenesis. 30 patients referred for investigation of a breast lump or abnormal mammogram were examined using functional imaging techniques. MR flash 3D images were acquired before and after enhancement with Gd-DTPA (TR = 0.06 s, TE = 0.013 s, FA = 50°). Flash 2D images were acquired following Gd-DTPA injection (TR = 0.06 s, TE = 0.013 s, FA = 50°). All patients had duplex Doppler ultrasound (10 MHz probe) to measure pulsatility index, resistive index and velocity readings within the mass. All masses were removed and the microvascularity of the specimens was analysed using specific immunohistochemical stains for endothelial cells. The *in vivo* dynamic enhancement of MRI contrast studies and pulsed Doppler flow patterns were compared with the *in vitro* vascularity of the tumour. A correlation between the enhancement patterns and size, grade and vascularity of tumour was evident. The peak velocity and pulsatility index also related to the degree of enhancement on the MR images and the *in vitro* vessel count. It is suggested that functional imaging techniques are able to predict tumour vascularity and consequently metastatic potential.

3.20 – 3.28 pm

Collaborative Phase III hyperthermia trial (MRC/ESHO/PMH) [Paper]

[1]C C Vernon, [2]J van der Zee and [3]F-F Liu

[1]Hyperthermia Department, MRC Cyclotron Unit, London W12 0HS, UK, [2]Department of Radiotherapy, Dr Daniel den Hoed Cancer Centre, 3075 EA Rotterdam, The Netherlands and [3]Department of Radiotherapy, Princess Margaret Hospital, Toronto M4X 1KG, Canada

The MRC Phase III Hyperthermia Study, which began in 1989, compares the effect of hyperthermia plus radiotherapy *versus* that of radiotherapy alone on patients with primary (inoperable) and recurrent breast cancer. So far a total of 177 patients have been randomized. This study is based at the Hammersmith Hospital, London, but has recruited patients from the whole of London and south-east England. Two similar studies commenced at a later date, in continental Europe (Netherlands) (ESHO—European Society for Hyperthermic Oncology), where 103 patients have been entered, and in Toronto, where 25 patients have been recruited. All ask the same basic question, *i.e.* does hyperthermia improve the response rate when added to irradiation? Although there are differences in the number of hyperthermia treatments given and the radiotherapy dose, these are not thought to present problems in analysis. It was decided to combine the three studies and to conduct a joint analysis of the combined total of over 300 patients. The combined study closed at the end of 1993, and we present the final results.

3.28 – 3.36 pm

The effects of restriction endonucleases on mammalian cells of different radiosensitivity [Paper]

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Department of Experimental Radiation Oncology, Paterson Institute for Cancer Research, Manchester M20 9BX, UK

The purpose of this study was to evaluate the mechanisms behind the differential radiosensitivity of cells. DNA double-stand breaks (dsbs) are thought to be the primary lesions involved in cell kill by ionizing radiation and restriction endonucleases (REs) can be used to assess their importance as a determinant of intrinsic radiosensitivity. Experiments have been carried out using CHO cells, a radiosensitive mutant line, xrs6, and two human cervical carcinoma cell lines, MS751 and ME180. These lines differ in sensitivity to ionizing radiation with values for surviving fraction at 2 Gy (SF_2) of 0.90, 0.84, 0.24 and 0.14 for MS751, CHO, ME180 and xrs6, respectively. REs were introduced into the cells by treatment with the bacterial toxin streptolysin O and sensitivity was assessed using clonogenic cell survival. The RE AluI caused significantly greater cell kill than Sau3AI in CHO, xrs6 and ME180 cells ($p < 0.05$) whereas MS751 was resistant to the effects of both enzymes. The cells differed in sensitivity to both REs with, in order of increasing sensitivity, MS751, CHO, ME180 and xrs6 for AluI and CHO, MS751, ME180 and xrs6 for Sau3AI. Both ME180 and xrs6 were significantly more sensitive to treatment with RE than their radioresistant counterparts, MS751 and CHO ($p < 0.05$). These differences could not be explained in terms of cell cycle distributions. There was a significant correlation between sensitivity to RE and SF_2 for Sau3AI ($r = 0.97$, $p = 0.04$) but not for AluI ($r = 0.83$, $p = 0.17$). In order to investigate the effect of methylation on dsb induction the isoschizomers MspI and HpaII were introduced into the cell lines. MspI caused more cell death than HpaII, but this difference was more marked in the radiosensitive lines, suggesting that there may be a greater degree of DNA methylation in radioresistant cells. Although there was no correlation

between Hpall induced cytotoxicity and SF_2 ($p > 0.40$), there was a trend towards increasing radiosensitivity with increasing sensitivity to MspI ($r = 0.91$, $p = 0.09$). This work supports studies that have suggested that dsb induction may be an important determinant of cellular radiosensitivity and suggests that the state of DNA methylation may also play a role.

3.36 – 3.40 pm

C-raf-1 proto-oncogene expression relates to intrinsic sensitivity to irradiation but not cisplatinum [Poster]

H M Warenius, P G Browning and P Maw
CRC Oncology Research Unit, Department of Medicine, The University of Liverpool, Liverpool L69 3BX, UK

We have previously shown a correlation between high c-raf-1 proto-oncogene expression and relative intrinsic cellular radiosensitivity in a series of 19 human *in vitro* cell lines covering a wide range of histological types. We have also demonstrated a lack of correlation between intrinsic sensitivity to cisplatinum and photon irradiation in 11 such cell lines. Here we show, that, in contrast to radiation, there was no relationship between intrinsic cisplatinum sensitivity and c-raf-1 expression in 16 cell lines. Innate sensitivity to cisplatinum was, however, related to high DNA ploidy ($r = 0.617$, $p = 0.011$). In keeping with our previous observations, there was no correlation between cellular sensitivity to irradiation and sensitivity to cisplatinum, and neither modality was related to the expression of c-myc or the ras family oncogenes. Six of the cell lines described above were selected for highest and lowest c-raf-1 expression. Of these, the three most radiosensitive cell lines (with concomitant high c-raf-1 expression) showed a significantly higher post-irradiation accumulation in the G2 phase of the cell cycle after doses of 2 Gy than the three most radioresistant cell lines.

3.40 – 3.48 pm

Morbidity of children whose grandparents had been subjected to occupational radiation exposure [Paper]

N P Petrushkina
Ministry of Health of Russian Federation, Institute of Biophysics, Branch N1, Chelyabinsk-65, Russia

The purpose of the present investigation has been to give a estimate of the morbidity of 1557 grandchildren of individuals occupationally exposed to chronic irradiation previous to conception. It is also intended to define the contribution made by radiation to the occurrence of revealed anomalies in the children. Mean equivalent doses of the gamma exposure to the gonads at the time of conception are 173 to 1453 mSv. The control group consisted of 466 children of similar age. There were no differences in disease incidence level, structure of the morbidity, per cent of children often being ill, frequency and structure of the congenital malformations between the main and control groups. Acute respiratory diseases during the second year of life occurred more frequently in children whose grandparents had had contact with ionizing radiation sources than in controls. In other age groups no significant differences between the main and control groups were found. Increased disease incidence during the second year of life coincided with the beginning of the children's visits to pre-school establishments and the period of adaptation to new microsocial conditions. To assess the influence of professional exposure and other non-radiation factors, multifactorial analysis was used. There was no relationship between the occurrence of anomalies in the state of health of the observed children and the occupational irradiation of their parents or grandparents. The role of factors of a non-radiation character has been confirmed.

3.48 – 3.52 pm

Serum uric acid level and hyperuraemia in workers exposed to chronic gamma irradiation [Poster]

V I Telnov and G V Zhuntova
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The evaluation of purine metabolism parameters in persons exposed to chronic gamma irradiation in different doses was the purpose of this study. 860 workers (615 males and 245 females) aged from 35 to 72, exposed to gamma irradiation in total doses of from 0.01 to 7.60 Gy were examined. Uric acid in serum and prevalence of hyperuraemia (more than 0.420 mmol l^{-1} in males and more than 0.360 mmol l^{-1} in females were the criteria) were determined. The relationships between these parameters and radiation exposure, age, sex and overweight in workers were studied by multiple regression analysis. A positive relationship between both serum uric acid level and the prevalence of hyperuraemia and total dose of gamma irradiation, sex (M *vs* F) and overweight was detected. There was a stronger relationship between serum uric acid level or hyperuraemia and total gamma irradiation doses in females than in males. The increase of serum uric acid level was found in persons with a total dose of over 0.50 Gy. We have shown that persons exposed to total gamma irradiation doses of from 0.50 to 7.60 Gy have suffered some changes in purine metabolism parameters.

3.52 – 3.56 pm

Inactivation of *Escherichia coli* by technetium-99m Auger electron influence [Poster]

[1]C R Silva, [1]J O Valsa, [2]M S Caniné, [1]A Caldeira-de-Araújo and [1,3]M Bernardo-Filho

Departments of [1]Biophysics and Biometry and [2]Pathology and Laboratories, Universidade do Estado do Rio de Janeiro, and [3]Centro de Pesquisa Básica, Instituto Nacional do Câncer, Rio de Janeiro, RJ-Cep 20551-030, Brazil

Technetium ($^{99}Tc^{m}$) has been used to label different molecules and cells which are used as radiopharmaceuticals in nuclear medicine procedures, and to label biological structures for basic research. This radionuclide is easily obtained from a $^{99}Mg/^{99}Tc^{m}$ generator, by a not expensive method. In addition it presents a 6-h half-life, low dose radiation with gamma and Auger electron emission and negligible environmental effects. However, its biological effects, mainly those due to Auger electron emission, are not well established. The energy propagated by ionizing radiations may be directly transferred to DNA, modifying its structure, or to an intermediate molecule such as water whose radiolysis generates oxygen reactive species (ORS) capable of damaging the cells. Here we studied, in a DNA repair mechanism proficient *Escherichia coli* K12S strain, the effect of the Auger electrons on the inactivation produced by $^{99}Tc^{m}$ (37 MBq ml^{-1}) exposure. With this aim a glass tube containing the culture was put into another with the $^{99}Tc^{m}$ solution in order to block the passage of Auger electrons but not the gamma rays. The results show that Auger electrons are mainly responsible for the inactivation effects, probably by the generation of ORS. (Research supported by CNPq, CAPES and UERJ.)

4.15 – 5.21 pm

Oncology Imaging IV

Royal Hall

4.15 – 4.40 pm

The subperitoneal conduits revisited in oncological imaging [Invited Review]

P F G M van Waes, M A M Feldberg and M S van Leeuwen

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Identifying an abnormal morphologic pattern in oncological imaging does not guarantee understanding of the exact localization within anatomic compartments and the dynamic spread of disease. In 1982 Oliphant and Berne conceptualized the "subperitoneal space". During fetal life the two major abdominal compartments develop, *i.e.* the peritoneal cavity and the retroperitoneum. The peritoneal mesothelium covers the bowel and abdominal organs creating connecting folds, *i.e.* mesenteries, ligaments and omentum which form a network and potential space interconnecting the abdominal organs and the retroperitoneum. It has been named the subperitoneal space and can serve as an important conduit for the predictable spread of intraabdominal disease. New in oncological imaging is the concept that the "mesenteries" of the oesophagus, pancreas, duodenum, ascending and descending colon and rectum persist from day 18 of our life after conception, providing subperitoneal spread of pathology originating outside the abdominal cavity towards the abdomen a logical basis, *i.e.* oesophageal carcinoma to celiac nodes or sigmoidal peridiverticulitis towards the posterior rectal space. It is important that these conduits are evaluated on abdominal scans defining the "blind" areas to the surgeon. With this dynamic concept of abdominal architecture kept in mind decision making in patient management will be facilitated.

4.40 – 4.44 pm

Pneumothorax during angiographic Hickman line insertion in patients with malignant disease [Poster]

K J Harrington, S A Kelly, P Morris and J E Jackson

Departments of Clinical Oncology, Haematology and Diagnostic Radiology, Hammersmith Hospital, Du Cane Road, London W12 0HS, UK

We analysed the risk factors for pneumothorax during angiographic subclavian Hickman line (SHL) insertion in patients with haematological (HT) and solid tumours (ST). 112 patients (55 HT, 57 ST) had 127 SHL inserted angiographically. Mean ages were 37.5 (HT) and 53.7 years (ST). Sides of insertion were: 112 left, 15 right; 31 single, 29 double, 67 triple lumen catheters were inserted. Nutritional status was assessed as body mass index (BMI $kg\,m^{-2}$). Ten pneumothoraces occurred (10/59 ST *vs* 0/68 HT; $p < 0.01$). ST were more cachectic than HT patients (BMI: mean 23.4 *vs* 24.7, median 21.9 *vs* 24.2, $p < 0.05$). Patients experiencing pneumothorax were older (mean 57.3 *vs* 44.6 years, $p < 0.01$) and more cachectic (BMI: mean 19.7 *vs* 24.5, median 19.6 *vs* 24.0, $p < 0.005$). For BMI < 19 *vs* $> 19\,kg\,m^{-2}$, pneumothorax rate was 5/8 *vs* 5/119 ($p < 0.00001$). Neither the side of insertion nor the gauge of the catheter correlated with pneumothorax. Pneumothorax complicating SHL is significantly more likely in elderly, cachectic patients with ST. For BMI $< 19\,kg\,m^{-2}$ this route should be avoided.

4.44 – 4.52 pm

Ultrasound-guided biopsy of suspected primary soft tissue tumours: does it have a role? [Paper]

[1]W Kincaid, [2]R Reid, [3]S Murray and [1]N C McMillan

Departments of [1]Radiology and [2]Pathology and [3]University Department of Orthopaedics, Western Infirmary, Glasgow G11 6NT, UK

This study aims to assess the clinical value of ultrasound-guided biopsy (USB) of suspected primary soft tissue tumour. To date 19 patients with the clinical suspicion of a soft tissue tumour have undergone USB of the lesion following imaging with plain radiography, computed tomography, ultrasound and in some cases magnetic resonance imaging. USB was performed using a Biopty gun (14 or 16G needle). 12 patients also underwent open biopsy and three had excision biopsy. The final diagnoses were: 11 primary tumours (including malignant fibrous histiocytoma (MFH), myxoid liposarcoma, fibrosarcoma and chondrosarcoma), two 'reactive' change, two abscess, one skeletal muscle (normal variant), one lipoma, one pigmented villonodular synovitis (PVS), one non-Hodgkin's lymphoma. Of

the 15 patients who underwent open or excision biopsy the USB was in complete agreement in 11. Open biopsy in one patient provided only necrotic tissue, with no tumour cells. The USB diagnoses in three cases were myxoma, malignant nerve sheath tumour and low grade MFH, which on open biopsy were considered to be fibroma, sarcoma and intermediate grade MFH. In two patients with abscess, open biopsy became unnecessary, and it was considered not to be required in a further two cases (PVS and musculo-aponeurotic fibromatosis). USB has proven a useful technique in suspected primary soft tissue tumours. It is relatively inexpensive and simple to perform on day-cases or outpatients.

4.52 – 4.56 pm
Early experience with intravascular stents in the palliative management of superior vena cava obstruction syndrome [Poster]
C B Loughrey and L C Johnston
Department of Radiology, Belfast City Hospital, Belfast BT9 7AB, UK

The superior vena cava (SVC) obstruction syndrome is a distressing complication of intrathoracic malignancy. It is characterized by cyanosis, swelling of the head, neck and arms, proptosis, distension of the veins of the neck and trunk and dyspnoea. It occurs in up to 5% of all lung carcinomas. The traditional treatment methods of radiotherapy and/or chemotherapy are effective in approximately 90% of cases but may take several weeks to relieve symptoms. We will discuss early experience with four patients with underlying malignancy who underwent palliative treatment with intravascular stents. The diagnosis of SVC obstruction was confirmed by digital subclavian venocavograms performed via an antecubital vein. The SVC was subsequently catheterized via the femoral vein using local anaesthetic and following angioplasty of the stenotic segment, Palmaz stents were introduced. The procedure was straightforward and well tolerated by the patients. All experienced rapid relief of their symptoms and no complications of the procedure have been seen.

4.56 – 5.21 pm
Imaging of malignant neoplasms of the oral cavity [Invited Review]
R Sigal
Institut Gustave Roussy, 94805 Villejuif Cedex, France

The treatment of malignant neoplasms of the tongue and/or floor of the mouth is based on a compromise between carcinological imperatives and functional and aesthetic requirements. In the surgical planning, increasing efforts have been made to avoid unnecessary resection of the mandible and of the tongue which may result in a degree of speech impediment and difficulty in swallowing. Although physical examination yields valuable information on tumour extent, computed tomography (CT) and magnetic resonance (MR) imaging offer a greater accuracy in disease staging. However, imaging of the oral cavity may be hampered by dental amalgam and patient motion (including swallowing) and therefore many physicians rely on physical examination data and conventional radiographs [REF]. The main aim of this course will be to compare the benefits of computed tomography (CT) and magnetic resonance (MR) imaging with the clinical stage (including the use of conventional radiographs) in the treatment planning. Emphasis will be drawn on extension across the tongue midline, extension in the deep portion of the floor of the mouth and mandible involvement.

4.15 – 5.32 pm

Genitourinary Imaging

Harewood Suite I

4.15 – 4.40 pm
Contrast media reaction: recognition and response [Invited Review]
B L McClennan
Mallinckrodt Institute of Radiology, Washington University School of Medicine, St Louis, Missouri 63110, USA

Acute reactions to the intravascular administration of contrast media, both high osmolar and low osmolar ionic or non-ionic agents, are uncommon. While the risk of contrast related reactions is clearly less with non-ionic media, a life-threatening reaction may occur with any compound, including Gd-based MRI contrast. A wide range of reactions may occur both immediately or sometime (delayed) after administration. They vary from mild, physiological side effects such as warmth, nausea and vomiting, to hives, bronchospasm, laryngeal oedema, hypotension or respiratory and cardiac arrest. Prompt recognition and response with appropriate use of specific drugs will optimize outcome with maximal patient benefit. Recognition and recommended treatment of the more common life-threatening reactions will be discussed.

4.40 – 4.44 pm
Ten questions on the renal effects of water-soluble contrast media [Poster]
P W G Brown, S Oldroyd, J Haylor and S K Morcos
Department of Diagnostic Imaging, Northern General Hospital, Sheffield S5 7AU, UK

We wished to investigate the mechanism responsible for the renal effects of water-soluble contrast media (WSCM). Ten questions about nephrotoxicity induced by contrast media were answered, using experimental data obtained from studying the functional effects of WSCM (Iotrolan, an iso-osmolar dimer, and diatrizoate, a high osmolar ionic monomer) on the isolated perfused rat kidney and from reviewing the literature. A new hypothesis explaining the mechanisms responsible for the acute renal functional effects (increase in renal vascular resistance and decrease in glomerular filtration rate (GFR)) of WSCM has been formulated. We conclude that the reduction in renal function produced by WSCM is predominantly mediated by the vasoactive peptide endothelin.

4.44 – 4.52 pm
Do we still take too many films? Auditing intravenous urography [Paper]
N J A Cozens
Department of Radiology, Royal Infirmary of Edinburgh, Lauriston Place, Edinburgh EH3 9YW, UK

The joint report by the Royal College of Radiologists and the National Radiological Protection Board, *Patient Dose Reduction in Diagnostic Radiology* (1990), recommends abandoning routine immediate and post-micturition films in intravenous urography, and utilizing fewer than six total routine films. A retrospective audit was carried out of 150 consecutive intravenous urograms in 1989 (before the report), and 150 in 1992, to determine whether improvements occurred following the report. Other aspects audited included availability of reports and X-rays, changes in referral practice, use of contrast media, and exclusion of the possibility of pregnancy in women of child-bearing age. The number of intravenous urograms utilizing a routine immediate film was reduced (χ^2, $p < 0.005$), unnecessary post-micturition films were also reduced (χ^2, $p < 0.001$) and the total number of films per examination decreased (95% CI, 0.48–1.16 films). Overall, the standards suggested in the report have not yet been attained. This audit has initiated implementation of measures to further reduce films taken during intravenous urography. The outcome of this will be monitored by repeating the audit cycle. Evaluation of intravenous urography in other centres by a similar audit is commended.

4.52 – 5.00 pm

Can radiologists manage reactions to intravascular contrast? [Paper]

P W G Brown, M Gandhi and S K Morcos
Department of Diagnostic Imaging, Northern General Hospital, Sheffield S5 7AU, UK

We wished to assess the ability of radiologists to manage acute adverse reactions to intravascular contrast media. We carried out a postal survey of 54 radiologists in the Yorkshire area. 34 replies were received (response rate 63%). 22 radiologists (65%) did not know the correct location of resuscitation equipment in their department. Nine radiologists (26%) did not consider direct medical supervision necessary after the administration of intravascular contrast medium. 30 radiologists (88%) normally left the patient to be supervized by the radiographer conducting the examination. 33 radiologists (97%) had observed reactions to intravascular contrast media during the 12 months preceding the survey, and four of these were life-threatening. 26 radiologists (76%) had had no formal training in cardiopulmonary resuscitation (CPR). Most radiologists surveyed need to revise some of the procedures for the management of specific contrast-medium reactions. No radiologist suggested administering intravenous fluids for acute anaphylaxis, but 12 (39%) stated an inappropriate dose of adrenaline and a further 10 (32%) were unable to remember the correct dose. The survey highlights the need for regular training in CPR in radiology departments and draws attention to the importance of the guidelines recently issued by the Royal College of Radiologists.

5.00 – 5.08 pm

Intravenous contrast media reactions: how do radiologists react? [Paper]

F Parrish, D Sadler, A Coulthard and J P Owen
University Department of Radiology, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP, UK

Are intravenous contrast media reactions (ICMR) managed competently? This study assesses radiologists' understanding of ICMR management with reference to recent RCR guidelines [1]. A confidential survey was sent to all radiologists in a single NHS region. General understanding of ICMR was assessed, in addition to management of specific minor, moderate and severe adverse reactions. Information on departmental resuscitation facilities and protocols was requested. 61/101 responses were received (46 consultants, 15 juniors). All respondents had managed a contrast medium reaction: 20% had treated a severe reaction within the previous five years. Knowledge of minor ICMR treatment was generally good. Management of severe ICMR was poorly understood, with only 4/61 (7%) matching the guidelines. Knowledge of optimal treatment of severe ICMR was inversely proportional to radiological seniority, being best understood by junior registrars. 30% of respondents were unaware of the departmental location of a defibrillator or ECG machine; 62% had no knowledge of or access to an oximeter; 30% had no departmental resuscitation policy. This study suggests poor understanding of severe contrast media reaction management amongst radiologists. Simplified guidelines based on the RCR recommendations but targeted to the management of severe ICMR are suggested: a simple flow-chart for display in the examination room is proposed.

Reference

1. ROYAL COLLEGE OF RADIOLOGISTS. *Guidelines for the Management of Reactions to Intravenous Contrast Media* (RCR, London) (1993).

5.08 – 5.12 pm

How reliable are ultrasound measurements of renal length in adults? [Poster]

[1]M Ablett, [1]A Coulthard, [1]R E J Lee, [1]D L Richardson, [1]T Rimmer, [2]T Butler and [1]J P Owen
[1]University Department of Radiology, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP, UK and [2]Department of Statistics, University of Newcastle, Newcastle upon Tyne, UK

Renal ultrasound assessment commonly includes measurement of bipolar length. Are these measurements reliable? Significant inter- and intra-observer variation has been reported for children, but there are no published data for adults. 20 adult subjects with no history of renal disease underwent renal sonography by three experienced operators on two separate occasions. Renal length was measured bilaterally with electronic calipers using the same 3.5 MHz sector transducer. The 120 observations were analysed using variation analysis to determine repeatability (intra-observer variation) and reproducibility (variation between observers). The average difference between repeated measurements for each of the three observers was 0.46, 0.32 and 0.63 cm respectively ($p < 0.001$). Repeatability was 1.2 cm (*i.e.* 95% of repeat measurements by the same observer would be within 1.2 cm). Reproducibility was 3.1 cm (95% of measurements of the same kidney by different observers would be within 3.1 cm). We conclude that repeated sonographic renal length measurements in adults may be of value if performed by the same operator. Different operators vary widely in estimating renal length. Serial renal measurements in adults should be interpreted with caution if follow-up scans are performed by different sonographers.

5.12 – 5.16 pm
Atypical sonographic appearances of angiomyolipoma [Poster]
D M A Jackson, C D Collins, N Patel, R Jager, N Damani and D O Cosgrove
Department of Diagnostic Radiology, Hammersmith Hospital, London W12 0HS, UK

Renal angiomyolipoma is a benign hamartomatous neoplasm. It accounts for 1% of surgically resected renal tumours and is present in 11% of kidneys at autopsy. On ultrasound the lesion usually has very high level echoes which are intensely echogenic. These appearances are often sufficiently characteristic for a confident diagnosis to be made without recourse to CT or biopsy. We present three cases where atypical features on ultrasound necessitated further imaging (and in one case segmental resection) before the diagnosis of angiomyolipoma could be substantiated. In the first case, in a patient with tuberous sclerosis, the parenchyma of both kidneys were entirely replaced by echogenic material; in the second case there were multiple echogenic nodules distributed uniformly along the cortical margin and in the third case the lesion had a well defined mixed echogenic "spoke wheel" appearance in a single remaining kidney. All the patients had normal renal function. The literature is reviewed, the role of CT, angiography and surgery outlined and a suitable algorithm for imaging these patients proposed.

5.16 – 5.20 pm
Radiological signs in Von Hippel-Lindau disease [Poster]
H C Burrell, M L Wastie and R H Gregson
Department of Radiology, University Hospital, Nottingham NG7 2UH, UK

Von Hippel-Lindau disease is an autosomal dominant disorder characterized by the development of neurorectodermal tumours. In 1988 the gene for the disease was mapped to the short arm of chromosome 3 and recently the gene has been isolated. The radiological manifestations of Von Hippel-Lindau disease are numerous. We have reviewed the radiological findings in 13 patients from four families presenting in Nottingham since 1988 and these are illustrated. The most common radiological manifestation amongst these 13 patients was the presence of multiple renal cysts. There were seven renal cell carcinomas, six phaeochromocytomas, four cerebellar haemangioblastomas and four patients with pancreatic cysts. One of the patients had a carcinoid tumour of the common bile duct as well as multiple renal cysts, a renal cell carcinoma and a phaeochromocytoma. (Carcinoid tumour has not been previously described in Von Hippel-Lindau disease). Familial clustering of particular lesions has been reported in Von Hippel-Lindau disease and we also found this amongst our patients, with four out of the six phaeochromocytomas seen in the patients from one family. The follow-up of these patients and screening of affected families are problematical and the Nottingham surveillance programme is described.

5.20 – 5.24 pm
Computed tomographic and magnetic resonance evaluation of xanthogranulomatous pyelonephritis [Poster]
D A Scullion, P Grech and M A Al-Kutoubi
Department of Diagnostic Radiology, St Mary's Hospital, Paddington, London W2 1NY, UK

Xanthogranulomatous pyelonephritis (XGP) is an uncommon but well-described chronic renal infection seen particularly in diabetic patients and those with renal calculi. It is almost invariably associated with chronic pyuria. The condition is important because it may present in a non-specific fashion with anorexia, weight loss, high ESR and PUO. Under these circumstances the presence of a renal mass may be mistaken for malignancy but the correct interpretation of appropriate imaging should lead to the correct diagnosis. Between 1984 and 1993 at our institution we have examined nine patients with this condition, all with computed tomography (CT), and latterly one patient with magnetic resonance imaging (MRI). In all cases the correct diagnosis was suggested pre-operatively. We highlight the characteristic features of XGP on both CT and MRI, and illustrate the usefulness of establishing the exact extent of the disease process before surgical resection is undertaken.

5.24 – 5.32 pm
10-year follow-up of a cohort of adult patients with chronic pyelonephritis [Paper]
D Geetha, J P Owen, V Martinek, R Wilkinson, T H J Goodship, J S Tapson and M K Ward
Departments of Radiology and Renal Medicine, Royal Victoria Infirmary and Freeman Hospital, Newcastle upon Tyne, UK

The Newcastle Chronic Pyelonephritis Survey is a long-term project evaluating the natural history of the disease in adult life. We present a cohort of 153 patients diagnosed by excretion urography or at nephrectomy, followed up for a minimum of 10 years. There were 133 females and 20 males with an average age at presentation of 31 years and a mean period of follow-up of 13.8 years. Urinary tract infections (UTI), hypertension and complications of pregnancy were the commonest modes of presentation but 6% were picked up incidentally at excretion urography. Approximately one-third had a family history of renal disease. Of 149 patients diagnosed by excretion urography, 79 had unilateral and 70

bilateral disease. Unilateral disease and all scarring were most frequent in the right kidney. Patients with hypertension or proteinuria had a higher incidence of bilateral disease. Comparison of 39 patients who had impaired renal function with a control group matched for age and sex showed that bilateral disease and proteinuria were poor prognostic features. 28 patients developed end-stage renal failure in an average of 6.27 years from diagnosis. 55% of pregnancies were complicated by UTI, hypertension or oedema. Still-births and neonatal deaths were markedly higher than in OPCS data.

4.15 – 5.30 pm

Teach-in: Medical Genetics

Charter Suite

Medical genetics in diagnostic radiology [Invited Review]

J M Connor
Duncan Guthrie Institute of Medical Genetics, Yorkhill, Glasgow G3 8SJ, UK

Illnesses which are genetic or part-genetic affect one in 20 people by 25 years of age and, with their contribution to common disorders of adulthood such as cancer and dementia, affect 60% of the population during their lifetimes. Recognition of the genetic component of these illnesses is important for identification of at-risk relatives and for clarification of individual prognosis. This recognition can be assisted by analysis of the patient's pedigree, DNA, chromosomes or biochemistry and by use of specialized syndrome databases. Regional Genetics Services have been created throughout the UK to assist non-geneticists in the use and interpretation of genetic testing and to provide clinical services for patient assessment and genetic counselling of patients and their relatives.

Medical genetics in oncology [Invited Review]

M Steel
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A few forms of cancer (mainly rare) occur predominantly in a familial pattern, clearly indicating a genetic cause. Numerically, however, the minor subset of common cancers (breast, ovary, colon etc.) that result from heritable mutations constitutes a much bigger problem in clinical genetics. Around 5% of common tumours are believed to fall into this category but the proportion is higher among early onset cases. Many patients are aware of their strong family history of cancer and are now coming forward for counselling and investigation. The mode of inheritance is usually autosomal dominant with limited penetrance, *i.e.* what is inherited is a risk not a cancer. Most familial cancer syndromes are attributable to mutation in one copy of an allelic pair of tumour suppressor genes. A few of these have been identified and one that is likely to prove of major clinical significance, BRCA-1, has been mapped to a small region of chromosome 17q. The management of familial cancer involves determination of risk as accurately as possible and the institution of appropriate screening and/or intervention programmes. Psychological and practical/ethical issues (*e.g.* life assurance) also need to be addressed.

Wednesday 25 May

9.00 – 10.29 am

Advances in CT & Body Imaging

Royal Hall

9.00 – 9.25 am
The impact of spiral CT in oncological imaging [Invited Review]
P F G M van Waes, M S Van Leeuwen, T M T W Lock and J Noordzÿ
Radiology Department, University Hospital Utrecht, Heidelberglaan 100, Utrecht 3564 CX, The Netherlands

Spiral CT with a high-output X-ray tube (MRC 200 Philips; 5.2 Mega Heat Units, 11 kW cooling) offers 50 rotation uninterrupted volumetric data acquisition without misregistration. Most patients can hold their breath for 40–50 s. Slow expiration at the end does not cause artefacts. Movements cause "wrinkling" of multiplanar reformation (MPR) but do not deteriorate the diagnostic value. Evaluation of 585 oncological spiral scans showed the following indications: abdomen 302, chest 230, head and neck 53 and no brain tumours. Screening for malignancies with 10–5 mm spiral width and table feed proved to be more diagnostic than regular slice-to-slice scanning. Pattern recognition and therefore staging is facilitated by viewing in the interactive movie mode and MPR with overlapping reconstruction. 3D surface rendering proved to be a unique tool for diagnostic understanding and planning of surgical management in complicated morphology and advanced tumours reducing the need for additional radiological work-up. In the liver, fourth generation portal branches are visualized against only two generations in MRI. Customized electronic scalpelling is based on customized visualization of the variations of Couinaud liver compartments after 4-phasic (plain, arterial, portal and equilibrium) contrast examination within 2 min. SR scanning proved life saving in deep tracheal tumours prior to stenting.

9.25 – 9.33 am
Spiral CT angiography in the preoperative assessment of abdominal aortic aneurysm [Paper]
J M Ferguson, J Addison, A R Wright, I Gillespie, M Connell, W G Tennant and C V Ruckley
Departments of Radiology, Medical Physics and Vascular Surgery, Western General Hospital, Edinburgh, EH4 2XU, and Royal Infirmary of Edinburgh, Edinburgh EH3 2YW, UK

Spiral CT angiography (SCTA) is a minimally invasive technique for producing 3D vascular images from IV contrast-enhanced spiral-CT data. The study aims to assess whether SCTA can provide an accurate and complete depiction of the important features of abdominal aortic aneurysm (AAA) prior to surgery. 15 patients with AAA undergoing assessment with conventional percutaneous arteriography (CPA) were further investigated with a high-definition SCTA scan through the proximal part of the aneurysm. A further, standard spiral CT scan was then performed below this to show the distal extent of the aneurysm, and the iliac vessels. The arteriograms and SCTA scans were assessed independently for number of renal arteries, extent of renal artery disease, relationship of the proximal part of the aneurysm sac to the renal vessels, and distal extent of the sac. Perianeurysmal disease was evaluated on the CT scans. Good correlation was obtained between SCTA and CPA for renal artery number and disease. The extent of the aneurysm sac and perianeurysmal disease were better assessed with SCTA. Spiral CT angiography is able to provide all the preoperative information required by the surgeon in a single, minimally invasive examination.

9.33 – 9.37 am

The imaging of spontaneous internal carotid artery dissections: ultrasound, angiographic and dynamic spiral CT appearances [Poster]

P S Sidhu, H R Jäger, N D Jonker, A J Lopez and K T Khaw

Department of Diagnostic Radiology, Kings College Hospital/Hammersmith Hospital, London SE5 9RS, UK

While traumatic dissection of the internal carotid artery (ICA) is readily diagnosed clinically, spontaneous dissection of the ICA is a relatively uncommon cause of cerebrovascular symptoms in young and middle-aged patients. Angiographic findings include irregular narrowing, tapered narrowing (rat's tail), occlusion and an intimal flap. Colour Doppler ultrasound (CDUS) and dynamic contrast-enhanced spiral CT with 3D reconstruction provide alternative imaging modalities, which could replace angiography in the follow-up of these patients. A series of five patients (two men and three women), age range 41–59 years (mean 47.4) with spontaneous dissection of the ICA underwent angiography and CDUS (Acuson 128/XP10) at presentation. CT (Siemens Somatom Plus) was undertaken in two patients. Three patients had irregular narrowing of the ICA, one demonstrated the classical rat's tail appearance with an occlusion, and a dissection flap was found in one patient. CDUS readily demonstrated all these abnormalities but angiography failed to demonstrate the intimal flap. CT demonstrated narrowing and occlusion of the ICA clearly but not the intimal flap. We conclude that in spontaneous dissections of the ICA, CDUS is a useful imaging parameter and should be the first-line investigation both in the diagnosis and follow-up. Angiography remains useful for evaluating the intracranial circulation with CT, providing useful information when avoidance of the intra-arterial approach is necessary.

9.37 – 9.41 am

Spiral CT angiography: initial clinical experience [Poster]

A R Padhani, S Rankin, J Reidy, D Hawkes and P Taylor

Departments of Radiology and Vascular Surgery, Guy's Hospital, London SE1 9RT, UK

We aim to illustrate the technique of spiral CT generated multiplanar reconstructions and 3D angiograms. Spiral computed tomography (CT) couples continuous tube rotation and irradiation with continuous patient motion. We have used this unique method of acquiring volumetric data with the dynamic injection of intravenous contrast medium to image the vascular tree. Using imaging processing techniques, including surface shading and maximum intensity projections, it is possible to obtain 3D angiograms. We have applied these techniques to image the abdominal aorta and the renal and carotid arteries, and correlated the appearances with arteriograms. Spiral-generated angiograms show excellent anatomical detail of large and medium vessels. We present our initial clinical experiences. Spiral CT angiography shows promise and has a potential role as a non-invasive vascular imaging technique.

9.41 – 9.49 am

Dynamic CT perfusion imaging of the transplanted liver [Paper]

[1]R Sinnatamby, [2]C J E Watson, [3]G Alexander, [4]M P Hayball and [1]K A Miles

Departments of [1]Radiology, [2]Surgery, [3]Medicine and [4]Medical Physics, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK

Adequate arterial and portal perfusion are fundamental to liver allograft survival. Angiography is invasive and provides little functional information. Doppler ultrasound analysis is limited to major vessels and their lobar branches. We have explored whether dynamic CT can provide an alternative non-invasive method of assessing tissue perfusion. We studied seven patients and five controls, using a single-location dynamic series at an anatomical level displaying liver and spleen, performed after rapid intravenous bolus of contrast medium. Arterial and portal perfusion were calculated from hepatic time–density curves. Pixel-by-pixel analysis allowed creation of functional images. Reduced portal and increased arterial perfusion were found in one patient with thrombus within the portal vein. Normal arterial perfusion was confirmed in a patient with an occluded right hepatic artery but good collaterals. Normal portal perfusion was demonstrated in a patient with a portal vein stenosis later found to be functionally insignificant. Two patients with chronic rejection had reduced arterial but preserved portal perfusion, whilst the reverse was seen in a third. Recurrent liver tumour increased arterial perfusion. CT perfusion imaging allows non-invasive functional assessment of liver allografts with quantification of global and regional arterial and portal perfusion at capillary level.

9.49 – 9.53 am

CT perfusion imaging of the human pancreas [Poster]

[1]K A Miles, [2]M P Hayball and [3]A K Dixon

Departments of [1]Radiology and [2]Medical Physics, and [3]University Department of Radiology, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK

Measurement of human pancreatic perfusion is extremely difficult. We have previously described measurement of

tissue perfusion and creation of functional images using dynamic CT. This paper describes its application to the pancreas. 11 patients were studied. Nine control patients with a normal pancreas had undergone dynamic CT for investigation of liver disease; the pancreas had fortuitously been included in the images. Two patients with pancreatic disease were also studied: one with an islet cell tumour, and a diabetic with a pancreatic transplant. Excluding one patient with Wilson's disease with unusually high pancreatic perfusion, normal values fell between 1.25 and 1.66 ml min $^{-1}$ ml $^{-1}$ (mean 1.5). Overall perfusion of the islet cell tumour was raised, at 2.11 ml min^{-1} ml $^{-1}$. In the diabetic patient, perfusion of both native and transplanted pancreas was lower than normal (0.60 and 0.97 ml min $^{-1}$ ml^{-1} respectively). Perfusion images are presented. No reference value for normal human pancreatic perfusion is available but the CT values are comparable with those recorded in animals. The changes with pancreatic disease are in accordance with known pathophysiology. The high spatial resolution and functional information afforded by perfusion CT make the technique well suited to studying perfusion in the human pancreas.

9.53 – 10.01 am
Dynamic CT perfusion imaging of the brain: iodine or xenon? [Paper]
[1]R Sinnatamby, [1]K A Miles, [2]M P Hayball and [3]A K Dixon
Departments of [1]Radiology and [2]Medical Physics and [3]University Department of Radiology, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK

Xenon CT, an accepted technique for quantifying regional cerebral perfusion, has many inherent limitations. We explore the potential of an alternative technique for quantitative perfusion imaging using conventional CT equipment and iodinated contrast media. Ten patients were studied using a Siemens Somatom Plus CT system. Single-location dynamic sequences were performed through the basal ganglia, following a rapid bolus of intravenous Iopamidol 300 mg ml^{-1}. Pixel-by-pixel analysis was used to create quantifiable functional images of perfusion. Functional images revealed marked intrasubject variability in cortical perfusion. Radial profiles were used to quantify perfusion. In each patient, peak (cortical) and trough (white matter) perfusion values were obtained from four separate profiles. Perfusion values (cortical peak, mean 0.67 ml min $^{-1}$ ml $^{-1}$, range 0.47–1.00, $n = 10$; and white matter, mean 0.12 ml min^{-1} ml^{-1}, range 0.09–0.15, $n = 10$) correlate well with measurements from xenon CT. In four patients with cerebral malignancy, areas of adjacent oedema showed markedly reduced perfusion (mean 0.11 ml min $^{-1}$ ml $^{-1}$). So too did an infarct in another patient (0.09 ml min^{-1} ml^{-1}). Perfusion measured within a glioma was 0.51 ml min $^{-1}$ ml $^{-1}$. Dynamic CT appears to achieve quantifiable images of cerebral perfusion with good anatomical resolution.

10.01 – 10.09 am
Can volumetric CT offer a routine alternative to conventional scanning techniques? [Paper]
A G Chalmers and L Gathercole
CT Scanning Department, Leeds General Infirmary, Leeds LS2 9NS, UK

The Philips 7000 SR incorporates a Maximus ROTALIX Ceramic (MRC) 200 CT tube which has a heat capacity of 5.2 MHU and an anode cooling rate of 900 kHU min $^{-1}$. This permits a 50 cm patient volume to be acquired in 50 s by a scanning technique which produces quality images for thoracic and abdominal examinations. We review the first 200 patients who underwent volumetric scanning at the Leeds General Infirmary. Image quality, diagnostic value, radiation dose, contrast load and patient tolerance are discussed. Contrast load and radiation doses were significantly reduced and patients' preference for a single breath-hold was significant. We conclude that volumetric scanning using systems with state-of-the-art tube technology offers a routine alternative to conventional stop/start scanning.

10.09 – 10.17 am
Use of spiral CT and 3D reconstruction in the preoperative diagnosis of scoliosis [Paper]
Th Lange, H Halm, T M Link and P E Peters
Institute for Clinical Radiology, Westfaelische-Wilhelms-Universitaet, Albert-Schweitzer-Str.33, 48129 Muenster/Westfalen, Germany

The preoperative X-ray of the spine often presents with insufficient information on spinal anatomy, especially in severe scoliosis together with torsion. This may have serious consequences for the method of operation. The purpose of this study was to determine the value of spiral CT with 3D reconstruction in the planning of the operation. Patients with severe thoracic and/or lumbar scoliosis underwent spiral CT (SR 7000; Philips) in addition to conventional radiography. Slice thickness and table increment were 10 (5) mm. The index of reconstruction was 4 (2) mm. This was followed by 3D reconstruction using the system software. The surgeon compared the set of 3D images with the intraoperative findings. 3D CT images proved superior to conventional radiography and had a decisive impact on the planning of the operation in some patients. In congenital scolioses the type of formation as well as the type of segmentation could be depicted more clearly. The 3D CT

findings corresponded well with the intraoperative situs. We conclude that 3D CT improved preoperative imaging of idiopathic and congenital scolioses.

10.17 – 10.25 am

Comparison of inspiratory PA radiograph and spiral CT in assessing percentage pneumothorax (%PTX) size [Paper]

C D Collins, A Lopez, A Mathie, V Wood, J E Jackson and M E Roddie

Department of Diagnostic Radiology, Hammersmith Hospital, London W12 0NN, UK

The aims of this study were (a) to compare the performance of observers with different levels of experience in assessing %PTX size on inspiratory PA radiographs with the "gold standard" of spiral CT, and (b) to compare Rhea's [1] method of assessing %PTX size using average interpleural distance (AID) with spiral CT. 17 pneumothoraces from 16 patients were analysed. All patients had an inspiratory PA radiograph and spiral CT of thorax performed on the same visit to the radiology department. Four observers (two experienced, two inexperienced) assessed %PTX size on the PA radiograph; the AID was calculated by one of the inexperienced observers. Following spiral CT, regions of interest outlining the borders of lung and hemithorax were drawn on reconstructed 10 mm sections and the %PTX calculated by dividing the volume of free air by the volume of the hemithorax. A significant underestimation of true PTX size was made by all observers using the PA radiograph ($p < 0.005$). This difference was accentuated as the PTX size increased. A significant underestimation was also demonstrated when AID was used to calculate %PTX size ($p < 0.003$). Using standard deviations of the ratios between observers and CT, no significant difference between the performance of inexperienced and experienced observers was demonstrated. This study demonstrates a significant underestimation of %PTX size using the PA radiograph which did not significantly vary with the observer's experience.

References

1. RHEA, *Radiology, 144*, 733–736 (1982).

10.25 – 10.29 am

How useful is CT scanning of the orbits and brain in the investigation of optic disc swelling? [Poster]

[1]A K Banerjee, [1]E Denton, [2]F Cordeiro, [2]E Graham and [1]K A Tonge

Departments of [1]Radiology and [2]Ophthalmology, St Thomas' Hospital, London SE1 7EH, UK

Optic disc swelling has a wide range of causes, ranging from raised intracranial pressure, hypertension, optic disc inflammation or ischaemia to intraorbital tumours or infiltrative processes. A CT scan of the orbit and brain was the chosen modality for evaluation in this group of patients. We have performed CT scans of the orbit and brain in patients presenting with clinical optic disc swelling, and present our results over a 3-year period. A total of 45 patients were scanned (22M, ages 13–72, mean age 46.6 years; 23F, ages 21–82, mean age 42.6 years). The scans of the orbit were performed using 4 mm increments and the scans of the brain were performed at 8 mm intervals. The suspected clinical diagnoses before scanning were: benign intracranial hypertension (8), optic nerve infiltration (4), optic neuritis (2), thyrotoxicosis (1) and sarcoid (1). In the rest of the cases (29), the clinical diagnosis was not clear. Abnormal radiological findings on the scans included: optic nerve swelling (5), cerebral atrophy (4), sinus disease (3), bilateral drusen (2), cerebral infarct (2), thyroid eye disease (1), orbital glioma (1), astrocytoma (1), antral aspergilloma (1) and hydrocephalus secondary to tuberculous meningitis (1). A total of 24 of the 45 (53%) scans were abnormal. The study shows that scanning the orbits and brain in patients with optic nerve swelling is clinically useful and has a high yield of radiological abnormalities.

9.00 am – 12.00 noon

Workshop: Interventional Radiology (Co-organized with BSIR)

Harewood Suites I & II

Vascular stents [Invited Review]

P A Gaines
Vascular Services, Royal Hallamshire Hospital, Glossop Road, Sheffield S10 2JF, UK

Arterial vascular stenting is becoming accepted practice. In the aortoiliac region they have been shown to be safe and have an improved complication rate and 5 year patency rate when compared with conventional balloon angioplasty. The present indications are: (1) a residual gradient due to elastic recoil following PTA; (2) flow limiting dissection; (3) complete iliac occlusions. In the femoro-popliteal region stents have a high acute closure and restenosis rate and should only be used for bale-out situations. Technique, data, and future developments are presented. Metallic stents have also been used in the subclavian, brachial, carotid, and renal vessels but meaningful data are not yet available. Venous stenting has been used to manage superior vena caval obstruction and our unit has shown a 90% primary success rate in both simple stenoses and complete occlusions with excellent patency to death. The same devices have also been of benefit in the IVC and subclavian veins.

Biliary intervention [Invited Review]

D F Martin
Department of Radiology, Withington Hospital, Manchester M20 8LR, UK

The aim of this presentation is to highlight new developments in non-operative management of biliary disease. Nowadays the majority of patients with normal upper gastrointestinal anatomy with bile duct stones have these dealt with endoscopically, as this offers the quickest, simplest and most effective therapeutic option. The same is true for patients with common duct malignancy who can be readily dealt with using endoscopically placed plastic stents. The situation is less clear with regard to tumours which involve the confluence of the hepatic ducts and spread into subsegmental or segmental ducts. There is still room for debate with regard to the evaluation of these patients for surgery and their definitive management with plastic or metal stents, perhaps complemented by brachytherapy. The aggressiveness with which surgeons will nowadays tackle these lesions has changed and this fact alone must change the radiological approach to the patient. For patients whose biliary system is inaccessible with the endoscope, percutaneous procedures assume an important primary role. The management of the difficult problem of bile duct stone and stricture is generating ever more ingenious solutions. Percutaneous cholangioscopy and transhepatic lithotripsy in various guises are likely to become more widely available and acceptable, thereby reducing even further the small number of patients who still require open surgery as a solution to their choledocholithiasis.

The idiot's guide to ... thrombolysis [Invited Review]

G Plant
Department of Radiology, Basingstoke Hospital, Basingstoke, Hants RG24 9NA, UK

In many hospitals in the UK the presence of pathological clot (thrombus and embolus) in a peripheral artery is treated by percutaneous injection or infusion of thrombolytic agents (tissue plasminogen activator, streptokinase or urokinase) in the radiology department. The technique most commonly used is local low dose infusion. This has the advantage of minimizing disruption to the X-ray department by these cases, which are usually unscheduled emergencies. It is well tried and successful and the standard techniques will be described. The disadvantage of local low dose infusion techniques is the time taken to re-perfuse the affected limb. Average procedure times of 25–30 h are common and during this time patients are usually treated in high dependency units. Some patients cannot tolerate this length of ischaemia and in addition there are significant costs associated with it. There has, therefore, been considerable work on speeding up the technique and various methods of doing this will be discussed. Aspiration of thrombus, local high dose and pulse spray techniques will be described and the methodology explained. The practical use of thrombolysis in a radiology department will be described and the tactical decisions that need to be made during a course of treatment discussed. The presentation will be orientated towards the practicalities with emphasis on methods rather than results.

9.00 – 10.21 am

Ultrasound

Ripley Suite

9.00 – 9.25 am
What is ultrasound quality? Who needs it? [Invited Review]
J A Evans
Department of Medical Physics, Leeds General Infirmary, Leeds LS1 3EX, UK

Quality in all facets of health care is currently viewed as crucial. In diagnostic ultrasound there have been many attempts to test various aspects of equipment performance although not necessarily with quality control as an explicit objective. There has always been, and still remains, a tendency to confuse acceptance testing, quality assurance and performance comparison which do not of course have the same requirements. For QA, reproducibility, speed and cheapness would seem to be important although any system which does not have a high sensitivity to change is unlikely to be acceptable. There now exists a large number of "tissue equivalent" test objects which in many cases still rely on the old wire AIUM layout. Many of the principles are embodied in the recent BS5724 document which describes recommended test objects and procedures. However, throughout all of these developments, spanning some 20 years, there have been remarkably few attempts to evaluate the usefulness of the tests being proposed. In this review some data will be presented which suggest that there is a very poor correlation between test object results and operators' perception of imaging quality. Whether or not the subjective assessment of the operator is a reliable indicator of diagnostic potency is another issue. There is, however, some preliminary evidence that the grey scale transfer curve and the noise level of the scanner are of considerable importance and that the optimal requirement for these performance parameters may depend critically upon the clinical application. Lagging behind still further is the testing, quality control and assessment of Doppler ultrasound devices. In this case flow phantoms, moving string phantoms and other mechanical devices have been produced but all are now perceived to be limited. Again there is a paucity of evidence about the best quantities to measure as well as uncertainty about how to measure them. Other suggestions such as acoustic signal re-injection remain to be evaluated since there has been no commercial exploitation to date. Overall we are left with a situation in which much lip service is paid to the idea of quality in ultrasound but this is not matched by scientific effort, user commitment or resource. This cannot be regarded as satisfactory and urgent clarification is needed.

9.25 – 9.33 am
Ultrasound exposure and heating [Paper]
F A Duck, H C Starritt and S Morgan
Department of Medical Physics, Royal United Hospital, Bath BA1 3NG, UK

Standard methods for ultrasound exposure measurement are well established, using a hydrophone and a radiation force balance to measure intensities, powers and acoustic pressures. As temperature rise is now becoming established as an appropriate alternative exposure quantity, it is important to establish the relationships between acoustic and thermal exposures. A simple device consisting of a solid absorbing target with an embedded thermocouple has been investigated experimentally as a thermal exposure measurement probe for diagnostic ultrasound beams. Temperature increases in excess of 40°C have been generated in a clinical pulsed Doppler beam, using one particular experimental design in which the absorber is backed by air. Heating in imaging mode has never been observed to exceed 2°C. These measurements have enabled a study to be carried out of the validity of theoretical predictions that heating is proportional to the product of spatial average intensity and beam diameter.

Reference
DUCK, F A and STARRITT, H C, A study of the heating capabilities of diagnostic ultrasound beams, *Ultrasound Med. Biol.* (in press).

9.33 – 9.41 am

Colour Doppler Imaging: how useful is it and why? [Paper]

G T Rottenberg, U Patel, F Laoudi, S Howling and W R Lees

Department of Ultrasound, The Middlesex Hospital, London W1N 8AA, UK

Colour Doppler imaging (CDI) is perceived to be a major advance in ultrasound technology. It is believed to shorten examination time and provide additional diagnostic information, although the latter has only been proven in a narrow range of subjects. We have studied the value of CDI in a teaching hospital department. 900 patients were studied prospectively by two radiologists. The following were assessed after each examination: (a) use of colour or duplex Doppler and reason for use; (b) influence of modality on examination technique and diagnostic ability. A sub-study evaluated the impact of CDI on the speed of examination. CDI was used in 49% of patients and was felt to be of value in 32% (289/900). In 22% (198/900) the modality subjectively aided examination (principally for evaluation of anatomy) and in 10% (88/900) CDI aided diagnosis. Mean time of examination was lower with CDI but was not statistically different (6.3 ± 3.2 *vs* 6.8 ± 2.8 min; $p > 0.05$, Mann Whitney U test; figures are mean $\pm$ 1 S.D.). CDI subjectively aids examination, without significantly reducing examination time. In a minority of cases it positively aids diagnosis and this group will be further discussed.

9.41 – 9.45 am

Correlation between duplex Doppler ultrasonography and dynamic infusion cavernosography and cavernosometry (DICC) in the diagnosis of venous leak [Poster]

B J Lewandowski, A M Thijssen and J P Collins

Department of Radiological Sciences, Ottawa Civic Hospital, Ottawa, Ontario K1Y 4E9, Canada

We set out to define the relationship between serial resistive indices (RI) and DICC in the differentiation of arterial *vs* venous incompetence. Between October 1990 and July 1992, 21 patients with a history of compatible venous leak were evaluated to rule out venous leak as a cause of their erectile dysfunction (age 26–69, mean 47 years). All patients were evaluated with duplex Doppler ultrasonography, with determination of corporal artery resistive indices regularly over a 30 min period. If the resistance index reached 1.0, *i.e.* diastolic flow approached zero, patients were felt to have a competent veno-occlusive mechanism. All patients had Dynamic Infusion Cavernosography and Cavernosometry (DICC) regardless of the ultrasonographic findings. Of the 21 patients, five had peak arterial flows in one or both corporal arteries $< 20\ cm\ s^{-1}$. All five patients had venous leak according to ultrasound (US) but 3/5 patients had a normal DICC. In the remaining 16 patients, there was agreement in the diagnosis in only 11. Three patients had venous leak demonstrated on US but not DICC and two patients had a positive DICC but a normal US. A single RI of 1.0 does not exclude venous leak. Rather, it is the serial RI change with time that correlates with venous leak and should be used to assess arterial vs venous problems.

9.45 – 9.49 am

Quantitative correlation between the penile Doppler study (PDS), intracavernosal pressure and pharmacocavernometric values [Poster]

U Patel and W R Lees

Department of Radiology, The Middlesex Hospital, London W1N 8AA, UK

Penile Doppler study (PDS) is a useful first-line test in evaluation of cavernosal venous leakage as a cause of impotence. Whether it can also categorize the degree of leakage is unclear. We currently carry out pharmacocavernosometry immediately after PDS in all patients suspected to have venous leakage. Retrospective correlation has been carried out in 93 patients to study how valuable is the PDS in quantifying venous leak. We studied the relations between: (1) end diastolic velocity (EDV) on PDS and maintenance flow on cavernosometry; (2) EDV and time to detumescence; (3) EDV and erectile grade and intracavernosal pressure achieved. Results show that although our current test specificity has improved (from 69% to 78%) there is not a statistically significant linear relationship between EDV and maintenance flow or time to detumescence. Neither is measurement of end PDS intracavernosal pressure recording of any additional diagnostic value. The PDS can diagnose venous leakage, but cannot categorize the degree of leakage as defined by cavernosometry.

9.49 – 9.57 am

Assessment by Doppler ultrasound of early acute rejection following adult liver transplant [Paper]

[1]A W Mitchell, [1]J N P Higgins and [2]B R Davidson

Departments of [1]Radiology and [2]Hepatobiliary Surgery, The Royal Free Hospital Trust, Pond Street, Hampstead, London NW3 2QG, UK

The commonest cause of early graft dysfunction following liver transplantation is acute rejection. This diagnosis is based upon a deterioration of liver/synthetic function tests

and is confirmed by biopsy. Many patients are unsuitable for biopsy owing to clotting and platelet abnormalities and thus Doppler ultrasound may provide an alternative method for the detection of rejection. Applying the technique developed by Britton et al, which measures the hepatic venous pulsatility index (VPI) to diagnose rejection in paediatric liver transplantation, we have assessed a cohort of 26 adult patients. All patients had a Doppler ultrasound scan on Day 2 or 3 after transplantation, followed by a repeat examination on Day 5 within hours of biopsy. The ultrasonographic findings were graded into three groups: normal, rejection and uncertain. Of the patients with a normal VPI (14), seven demonstrated minor or minimal rejection on biopsy; in the remainder rejection was treated. Six patients had damped VPIs and therefore were designated as rejecting; this was confirmed on biopsy in five patients; however, one had minimal rejection and was not treated. Four patients were categorized as uncertain as the initial trace was damped and did not return to normal. A further four patients were excluded because the ultrasound findings could not be confirmed as biopsy was not performed. To date our study demonstrates that a normal VPI is unhelpful in excluding early rejection in adult liver transplant patients. However, a damped trace with a previously normal baseline is suggestive but not diagnostic of rejection.

Reference

BRITTON ET AL, *Clin. Radiol., 45,* 223–232 (1992).

9.57 – 10.05 am

"Power Doppler": evaluation of a new method of colour Doppler sonography [Paper]

R O Bude, J M Rubin, P L Carson, R L Bree and R S Adler

Department of Radiology, University of Michigan Medical Center, Ann Arbor, MI 48109-0326, USA

Conventional colour Doppler sonography (CD) is based upon the mean Doppler frequency shift. A new method of colour Doppler sonography, which we call "power Doppler", has been developed which is based upon the total integrated Doppler power spectrum. Theoretical advantages of power Doppler compared to CD include: (1) Background noise is displayed in a manner that increases the usable dynamic range of an ultrasound scanner, often allowing a 10 dB or slightly greater increase in colour gain compared to CD. (2) It is relatively angle-independent. (3) It does not alias. Power Doppler is now in routine use in our department, and studies are under way to evaluate its efficacy in a variety of settings. Here we present our preliminary findings. Power Doppler was performed with a Diasonics Spectra ultrasound unit (Milpitas, California, USA). Power Doppler is frequently superior to CD in the depiction of vascular flow, especially in the kidney where diffuse cortical perfusion is often demonstrated, which we liken to an "ultrasound nephrogram". Power Doppler has also been found useful in musculoskeletal sonography, depicting increased perfusion in inflammatory conditions (bursitis, tendinitis). It has also shown promise in neonatal cranial sonography, visualizing deeper intracranial vessels than can be demonstrated with CD. Although our results are preliminary, power Doppler appears to be a promising technique to improve the utility of colour Doppler sonography.

10.05 – 10.13 am

***In vivo* biochemical correlates of pulse-wave velocity aortic distensibility measurements using Doppler ultrasound [Paper]**

E D Lehmann, K D Hopkins, M G Taylor and R G Gosling

Divisions of Radiological Sciences, Chemical Pathology and Medicine, United Medical and Dental Schools of Guy's and St. Thomas' Hospitals (University of London), London SE1 9RT, UK

A non-invasive Doppler ultrasound technique for the assessment of aortic compliance based on the *in vivo* measurement of pulse-wave velocity along the thoracoabdominal aortic pathway is described. An approach for correcting for the effect of blood pressure on aortic distensibility is considered, and the derivation of an index of intrinsic distensibility which is independent of blood pressure is given. Overviews are provided of studies utilizing the technique to determine aortic compliance in medical disorders which predispose to premature cardiovascular disease, such as diabetes mellitus, familial hypercholesterolaemia and growth hormone deficiency. The significance of correlations between *in vivo* aortic compliance measurements and plasma concentrations of total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and insulin-like growth factor I are discussed. It is proposed that the measurement of aortic compliance in normal healthy individuals may be a useful *in vivo* research tool for investigating the effects of biochemical factors on the biophysical properties of the aortic wall. Furthermore, it is proposed that the routine clinical measurement of aortic distensibility corrected for blood pressure may prove a useful non-invasive tool for assessing patients' susceptibility to atherosclerosis as well as for monitoring their response to therapeutic interventions.

10.13 – 10.21 am

Transrectal ultrasound imaging of rectal veins and varices [Paper]

S H Lee

Department of Clinical Radiology, Manchester Royal Infirmary, Manchester M13 9WL, UK

To evaluate the use of transrectal ultrasound (TRUS) in determining the presence of rectal veins and varices in patients with known or suspected portal hypertension, 21 patients were prospectively imaged using a 7.5 MHz linear array probe: 16 patients had chronic liver disease and/or portal hypertension, and there were five controls with a variety of disorders not related to the liver or portal tract. 15 of the patients with chronic liver disease had readily visible veins in the rectal wall and/or the perirectal soft tissues, and seven patients demonstrated rectal varices. Of the five controls, rectal wall veins were only visible in one patient, who presented with rectal prolapse. TRUS would appear to be a highly sensitive technique for demonstrating the presence of rectal veins and varices in patients with known or suspected portal hypertension. Although the reported incidence of rectal varices (3–44%) is less than that of oesophageal varices, the finding of visible rectal and/or perirectal varices should alert the clinician to the possible consequences of rectal haemorrhage. The advent of transjugular intrahepatic portosystemic shunt placement may reduce the risk of catastrophic rectal bleeding in these patients.

9.00 – 10.30 am

Neuroradiology

Bramham Suite

9.00 – 9.25 am
MR of the thalamus [Invited Review]
R Sigal
Department of Radiology, Institut Gustave Roussy, Rue Camille Desmoulins, 94805 Villejuif Cedex, France

The aim of our study was to visualize the thalamic nuclei using high resolution magnetic resonance (MR) techniques. Spatial resolution can be improved by increasing the strength of the readout gradient or by lowering the receiver bandwidth. Both solutions were tested. *In vivo* MR examinations were performed with an experimental head coil allowing an increase of the readout gradient up to 5 Gs. cm^{-1} (50 mT. m^{-1}). 50 mm field of view images were obtained in 30 min with satisfactory contrast-to-noise ratio. The other approach was to reduce the bandwidth to 2 kHz (instead of 16 kHz in the standard operating mode). Gradient echo and inversion recovery images were acquired in 6–13 min with a field of view of 50 and 80 mm. *Ex vivo* studies were performed on thalamic specimen using a prototype gradient coil or a 2 kHz bandwidth. Fields of view were selected between 50 mm and 20 mm. *In vivo*, high resolution MR allows visualization of the geniculate bodies, the pulvinar, the anterior, medial and lateral nuclei. The stratum zonale, the internal medullary lamina and the mamillo-thalamic tract are also recognized. *Ex vivo*, MR analysis is better. However, the ventral lateral nucleus, where the principal targets of neurosurgical stereotactic thalamotomies are located, does not show any identifiable segmentation. High resolution MR should improve the accuracy of neurosurgical stereotactic procedures.

9.25 – 9.33 am
Assessment of morphological variation of the normal pituitary gland and its effect on volume [Paper]
S A Sukumar, C E Hutchinson and J M Hawnaur
Department of Diagnostic Radiology, University of Manchester, Manchester M13 9PT, UK

Recent studies have shown MR to be better than CT in the imaging of the pituitary gland. The morphological variation and normal measurements of the pituitary gland are important in recognizing pituitary gland pathology. Images from 3D spoilt gradient recalled echo (SPGR) volume data obtained on a 0.5 T Vectra in 40 healthy adults were analysed. The pituitary gland varied widely in shape from a gland with a deep cavity to a globular shape. It was postulated that the volume measurements by the traditional ellipsoid method would overestimate the gland size owing to the variable morphology. The overall gland volume and the separate volumes of the anterior and posterior pituitary were obtained by summation of the slice volumes and compared with a method in which the volume was calculated from two maximal transaxial diameters (a, b) and one linear sagittal diameter (d): volume = $abd\pi/6$. In both sets the trend was for the pituitary volume to be greater in females. The ellipsoid method gave a greater pituitary volume (mean F: 0.56 cm^3, M: 0.50 cm^3) in all but four cases. This can be explained by the wide variation in the shape found in the normal pituitary. We are now comparing these results with those for patients known to have pituitary adenomas to see if the volume change will separate these two groups.

9.33 – 9.37 am
Negative brain MRI in patients with multiple sclerosis: what should we do next? [Poster]
D B Stafford Johnson, A J O'Dwyer and J Toland
Department of Neuroradiology, Beaumont Hospital, Dublin 9, Ireland

The clinicopathological manifestations of multiple sclerosis (MS) are due to areas of demyelination that occur throughout the white matter of the central nervous system. Magnetic resonance imaging (MRI) of the brain in MS patients demonstrates abnormalities in the white matter and supports the clinical diagnosis in the majority of cases. We describe seven patients with a clinical diagnosis of MS who had symptoms suggestive of cerebral involvement alone without any clinical signs of spinal cord involvement. All seven had normal gadolinium-enhanced T_2 weighted MR scans of the brain. The seven patients subsequently had MR examinations of the spinal cord: all of these were abnormal. Findings included high signal plaques on

T_2 weighted imaging in all seven patients, and diffuse cord swelling in two. We conclude that spinal cord MRI in patients with suspected MS has a high positive predictive value for supporting the diagnosis, even in patients who have a normal brain MR scan and when cord symptoms are absent.

9.37 – 9.45 am

Structured reporting of MRI of the head in HIV [Paper]

[1,2]G H du Boulay, [2]B A Teather, [2]D Teather, [3]C Santosh and [3]J Best

[1]Institute of Neurology, National Hospital, London WC1N 3BG, [2]Department of Computing and Mathematical Sciences, De Montfort University, Leicester LE1 9BH, and [3]MRI Unit, City Hospital, Edinburgh EH10 5SB, UK

The neuropathology of early stages of HIV infection, prior to symptoms or detectable neurological damage, remains of importance in seeking or monitoring effective treatment. Questions of interest include: "Has the early occurrence of brain damage been obscured by the way the observed subjects have been grouped?"; "Is 'atrophy' fluctuating or progressive?"; "Can diffuse white matter changes be more meaningfully subclassified?"; "Can the specificity and consistency of MRI observations be improved?" 80 sets of MR images comprising 18 normals, 19 HIV-negative intravenous drug users (IVDU), 18 asymptomatic and 25 symptomatic HIV-positive subjects have been described blind, using a detailed structured computer-based reporting system. The reports provide information on number, position and appearance of lesions, and other signs including a graduated diagnosis of cerebral atrophy, and number and size of V-R spaces. Detailed comparisons of the structured reports suggest that: (1) there may be more atrophy in asymptomatic than in symptomatic subjects; (2) "dilatation" of posterior fossa cisterns appears to be virtually identical across the four groups; (3) there may be differences in the size and intensity of VR spaces between IVDU and asymptomatics (IVDU spaces appear wider and brighter). Difference in atrophy scores may be inverted if comparison is made on the basis of ODC groupings.

9.45 – 9.49 am

Intelligent tutoring for MR image interpretation and the diagnosis of cerebral disease [Poster]

[1]N P Jeffery, [1]B A Teather, [1]D Teather, [2]M Sharples, [2]B du Boulay and [3]G H du Boulay

[1]Department of Computing and Mathematical Sciences, De Montfort University, Leicester LE1 9BH, [2]Department of Cognitive and Computing Science, University of Sussex, Brighton BN1 9QH, and [3]Institute of Neurology, National Hospital, London WC1N 3BG, UK

This multidisciplinary collaborative research study is developing a computer-based tutoring system to assist the training of radiologists in (1) viewing and systematic description of abnormalities visible on MR images, and (2) interpretation and diagnosis of cerebral disease, particularly with respect to the differentiation between diseases that may present similar features on MR (*e.g.* glioma and infarct, multiple sclerosis and vascular disease). A dedicated archive of some 1121 cases illustrating a variety of pathologies, together with structured descriptions of the images produced by an expert radiologist, is being utilized in the tutor development. Statistical analyses, including correspondence analysis, have been applied to the database of structured descriptions to quantify the variation of image features within individual diseases. Statistically based measures of typicality and similarity have been defined and these will be used in strategies to select an appropriate image for interactive case-based tutoring and to actively guide the trainee through the image archive. The poster presents examples of interactions between trainee and tutoring systems and discusses the problems of system evaluation.

9.49 – 9.57 am

The application of quantitative magnetic resonance techniques in patients with schizophrenia [Paper]

[1]P McGilligan, [1]J MacEnri, [1]C M Moore, [2]A Lane, [2]P Buckley, [2]D Sloan, [3]D Cotter, [2]E O'Callaghan, [3]J L Waddington and [1]J T Ennis

[1]Institute of Radiological Sciences, University College Dublin, [2]Cluain Mhuire Family Centre and [3]Royal College of Surgeons, Dublin, Ireland

We aimed to evaluate metabolic and morphological alterations in schizophrenia quantitatively. Localized single voxel spectra were obtained in the frontal and temporal lobes of 28 patients and 20 healthy controls using a STEAM sequence (TE = 68 ms; VOI = 11 ml; TR = 3000 ms). Metabolite levels were obtained using manual integration. T_1-W coronal and sagittal images were also obtained for 30 patients and 15 healthy controls. Structural measurements were performed on a semi-automatic image processing work station. There were no significant differences between metabolic and morphological parameters in the patient and control groups. However, both morphological and metabolic differences were found between male patients and female patients and controls of both sexes. Also, relationships were found between metabolite levels and a number of clinical parameters. We conclude that magnetic resonance shows metabolic and morphological alterations in male patients with schizophrenia.

9.57 – 10.05 am

^{1}H MRS in supratentorial arteriovenous malformations [Paper]

^{1}C M Moore, ^{1}O M Redmond, ^{1}P J Gilligan, ^{2}C Georgopolous, ^{1}J P Stack, ^{2}S O'Laoire and ^{1}J T Ennis
^{1}Institute of Radiological Sciences, University College Dublin and ^{2}Department of Neurosurgery, Mater Private Hospital, 52 Eccles Street, Dublin 7, Ireland

We set out to investigate metabolite levels in a number of regions in the brains of patients with supratentorial arteriovenous malformations (AVMs) using ^{1}H MRS. Single voxel proton spectra (TE = 68 ms; TM = 30 ms; TR = 3 s) were acquired from patients with AVMs (5M; 8F, age 18–48) and healthy controls (10M, 10F, age 18–48). Volumes of interest were positioned adjacent to (n = 7), contralateral to (n = 9) and in the AVMs (n = 11). Mean N-acetyl aspartate (NAA) levels adjacent to the AVM were significantly lower ($p < 0.05$) and choline levels significantly higher ($p < 0.01$) in the patient group than in the control group. The patient group was divided into two classes: (1) no signal enhancement and (2) signal enhancement adjacent to the AVM. In Class 1 patients, NAA levels were significantly lower than in the control group ($p < 0.01$). In Class 2 patients, no significant differences in metabolite levels were observed between the patients and controls. For patients with no large lipid peak in the AVM, the mean NAA level adjacent to the AVM was significantly lower ($p < 0.05$) and Choline ($p < 0.05$) significantly higher than in the control group. Presence of a lipid peak in the AVM was correlated with poor outcome after surgery. We conclude that ^{1}H MRS allows identification of subgroups of patients with AVMs and may provide an indicator of post-surgical prognosis.

10.05 – 10.30 am

The value of dynamic MR imaging of pituitary tumours [Invited Review]

M Takahashi MD
Department of Radiology, Kumamoto University School of Medicine, 1-1-1 Honjo, Kumamoto 860, Japan

The diagnosis of pituitary tumours, especially differentiation from postoperative tissues, has often been difficult with routine MR imaging. It has been shown, however, that pituitary adenomas, either preoperative or postoperative, often demonstrate minor differences in contrast in the early phase of dynamic MR imaging. Dynamic MR imaging was performed with the spin echo technique (TR 200/TE 15 ms) every 30 s for 4–5 min, following rapid injection of Gd-DPTA in a dose of 0.1 mmol per kg body weight. (1) Macroadenomas before surgical or medical treatment show delayed enhancement. The normal pituitary tissue is enhanced earlier than this and contrast between the normal pituitary tissue and the pituitary adenoma is most prominent at the early phase of dynamic imaging. (2) Microadenomas also show delayed enhancement compared with the normal pituitary tissue. (3) Recurrent and residual adenomas reveal similar enhancement patterns to macroadenomas and microadenomas. (4) The surgical packing materials show further delayed enhancement, the peak time being at or later than 210 s. (5) Adenomas treated with bromocriptine show a similar enhancement pattern to that of surgical packing materials. In conclusion, dynamic MR imaging is an indispensable technique for differentiating pituitary adenomas from the normal and various postoperative tissues.

9.00 am – 12.00 noon

Workshop: Quality assurance in radiotherapy treatment planning: theory and practice

Charter Suite

9.00 – 12.00 am
Quality assurance in radiotherapy treatment planning: theory and practice [Workshop]
B Stubbs and A Crellin
Cookridge Hospital, Leeds, UK

Radiotherapy services throughout the country will be required to implement the recommendations of the Bleehan report "Quality Assurance in Radiotherapy". This process will involve everything from computerized treatment planning systems through to the practical aspects of patient management in the planning department. It seems likely that this will lead in many cases to an application for BS. 5750 registration. Treatment planning typifies the complex interrelationship between different disciplines that is required to ensure a patient receives the correct treatment. This session is designed to present speakers with expertise and experience in this area of quality assurance, from the technical aspects of a computer treatment planning system through to setting up a practical system in the department. Some practical results of the audit process and reviews of treatment planning will be presented with the CHART quality assurance as an example. To demonstrate the problem of translating quality standards into practice, speakers will present methods to improve outlining and homogeneity. Aspects of dose specification will be discussed. The session is designed to be of interest to physicists, radiographers and clinicians. (Please see the Programme page xxxv for a full list of speakers.)

10.45 am – 12.06 pm

Trauma

Royal Hall

10.45 – 11.10 am
Emergency radiology in the 90s: challenges in practice and education [Invited Review]
P O Alderson, MD
Department of Radiology, Columbia-Presbyterian Medical Center, New York, NY 10032, USA

Emergency radiology is changing in the USA. Technological advances have brought CT, ultrasound and teleradiology into the forefront of ER radiology. Liability risks and insurance costs are escalating and emergency room physicians are petitioning to interpret films without radiology input. Radiologists-in-training must be taught new and better ways to deal with this complex and evolving environment. To facilitate and document such training, an annual formal examination in emergency radiology has proven useful in our experience. The examination is a combination of a 20-question multiple choice written examination and a 20-film practical, given in sequence on the same day. The examination typically is given in June, both to educate and to credential residents for service in the ER for the following academic year. Several 1 h lecture sessions are scheduled the same week as a teaching exercise. All written questions and films are reviewed and discussed individually during these sessions. Fundamental concerns are covered each year, including cervical spine trauma, deceleration injuries of the thorax, blunt abdominal trauma, complex pelvic fractures and battered children, among others. Basic medical knowledge, image findings and work-up strategies are given equal weight during the test and follow-up educational sessions. Trainees have responded positively to this experience, which has been in use for 6 years. Rigorous approaches of this type are recommended to prepare trainees and document the credentials of radiologists for continuing primary involvement in emergency radiology.

11.10 – 11.14 am
Skull radiography in acute trauma—how many projections are necessary to detect vault fractures? [Poster]
R J Etherington S D'Souza and J Williams
Department of Radiology, Countess of Chester Hospital, Chester CH2 1BQ, UK

We proposed to determine whether skull projections in trauma can be minimized without loss of significant diagnostic information. Clinical details and radiographs of 135 patients with skull fracture were reviewed. Patients were grouped by clinical site of injury (anterior, posterior, vertex, lateral, unknown). Radiographs of patients in each group were assessed for visibility of a fracture and any associated diagnostic information. It was found that: *Anterior injury:* a frontal and lateral view would detect all 24 fractures. *Posterior injury:* a Townes and lateral view would detect all 45 fractures. *Vertex injury:* a frontal and lateral view would detect all 10 fractures. *Lateral injury:* a lateral view alone would detect 45/46 fractures. The frontal and Townes views added useful information in four cases and five cases respectively. *Site unknown:* a lateral view alone would detect 8/10 fractures. The frontal and Townes views added useful information in two cases each. Omission of the Townes view from cases of frontal and vertex injury and omission of the frontal view from cases of posterior head injury would reduce the overall number of films by 20% without loss of significant information.

11.14 – 11.18 am
Fatigue fractures of long bones of the lower limb: MRI appearances and comparison with CT [Poster]
P N M Tyrrell and A M Davies
Department of Radiology, Royal Orthopaedic Hospital, Birmingham B31 2AP, UK

Fatigue fractures may be confused with malignant bone lesions on plain radiography and thus are periodically referred for further imaging. Seven cases of fatigue fractures of the long bones of the lower limb are presented, in six of which a primary malignant bone tumour had been

suspected. Characteristic findings on MRI on T1W images consist of intramedullary bands of low signal intensity, continuous at some point with the cortex, indicative of a fracture line; intramedullary areas of high signal on both T2W and STIR images, representing marrow oedema or haemorrhage; together with evidence of periosteal oedema. To the unwary observer, the florid changes visible on MRI may be mistaken for evidence of intramedullary tumour tissue. The role of CT and MRI in the evaluation of fatigue fractures is discussed.

11.18 – 11.22 am
Pelvic insufficiency fractures [Poster]
G Walsh, P Hughes and M Williams
Department of Radiology, Derriford Hospital, Plymouth PL6 8DH, UK

Pelvic insufficiency fractures are poorly appreciated as a cause of pelvic pain in the elderly. They may cause difficulties in correct diagnosis in patients with known or suspected malignancy, where abnormalities on bone scanning and plain film may be interpreted as metastases. We present eight cases which demonstrate insufficiency fractures and emphasize the utility of CT in their diagnosis. CT is helpful in confirming these lesions and demonstrating their extent and can also show complications such as infection. The contribution of plain films, nuclear medicine and CT scanning in the diagnosis of elderly patients with pelvic girdle pain will be demonstrated.

11.22 – 11.30 am
The role of computed tomography in calcaneal fractures [Paper]
D E Roberts and R M Evans
X-Ray Department, Morriston Hospital, Swansea, UK

A retrospective study of the computed tomography (CT) appearances of calcaneal fractures in 23 patients (27 fractures) over a period of 12 months is presented. Magnetic resonance imaging was performed on an additional four patients both pre- and post-operatively. The scanning method, normal anatomy and fracture appearances are described. Many complex staging systems may be applied to these fractures; we apply a simple classification based on the Sander's CT classification and relate this to clinical management and prognosis. The present and future role of magnetic resonance imaging of these fractures is discussed. We conclude that CT is the pre-operative imaging modality of choice in calcaneal fractures and discuss a simple classification system and its relevance to management.

11.30 – 11.38 am
Computerized tomographic classifications of calcaneal fractures: reproducibility and reliability [Paper]
Q W Arafat, A M Davies, P B Pynsent, P N M Tyrrell and R M Wellings
MRI Centre, Royal Orthopaedic Hospital, Birmingham B31 2AP, UK

We aimed to assess the ease of use and reliability of four published CT classifications of intra-articular calcaneal fractures, proposed by Lowrie et al (1988) (A), Crosby & Fitzgibbons (1990) (B), Sanders (1992) (C) and Eastwood et al (1993) (D). 68 acute intra-articular fractures imaged by CT were assessed by three radiologists in accordance with the four classifications. 4 months later the exercise was repeated and the results analysed for intra- and inter-observer variability. For classification A, the mean intra-observer agreement was 80.1%, and mean inter-observer agreement was 67.6%. For classification B, the mean intra-observer agreement was 77% and mean inter-observer agreement 55.9%. For classification C, the mean intra-observer agreement was 68.3% and inter-observer agreement 34.8%. For classification D, the mean intra-observer agreement was 72.6% and inter-observer agreement 39.3%. We conclude that classification A, based on morphological patterns, and classification B, based on degree of fragment displacement, were the most reliable for intra-observer agreement. Classification C was the least reliable, probably reflecting its complexity. Inter-observer agreement was best for classification A, moderate for classification B and poor for both classifications C and D. The difficulties with these various classifications are discussed and illustrative cases shown to demonstrate the problems with each.

11.38 – 11.46 am
Secondary signs of anterior cruciate tears at MRI [Paper]
J C Hacking, R Mackenzie and A K Dixon
Department of Radiology, Addenbrooke's Hospital and the University of Cambridge, Cambridge CB2 2QQ, UK

The MRI diagnosis of anterior cruciate (ACL) tears is usually straightforward, especially with 3D imaging. However, the ligament may be obscured, rendering interpretation equivocal. In such cases analysis of secondary signs has been advocated. It was our purpose to evaluate the usefulness of these secondary signs. From our MRI records 25 patients with arthroscopically proven torn (11 patients) and normal (14) ACLs were identified. In six of these patients the ACL had been reported as being partially obscured. At review we assessed the shape of the posterior cruciate ligament (PCL) and the patellar tendon. We also looked for evidence of bone bruising, posterior femoral shift and a deepened notch within the lateral femoral

condyle. None of the secondary signs showed high sensitivity, but an abnormal PCL, excessive femoral shift, bone bruising and a deep lateral femoral condylar notch were all associated with ACL tears. An irregular patellar tendon was not a useful sign. Our results confirm that there are some helpful secondary signs in the assessment of the difficult anterior cruciate ligament.

11.46 – 11.50 am

MR imaging of normal ankle ligaments—comparison of 2D SE and 3D SPGR acquisitions at 0.5 T [Poster]

A K Jain, C E Hutchinson and J M Hawnaur
Department of Diagnostic Radiology, University of Manchester, Manchester M13 9PT, UK

Ankle stability is dependent on lateral and medial collateral ligaments and the syndesmotic ligamentous complex. 85% of ankle sprains are inversion injuries involving the lateral collateral ligament while 15% are eversion injuries involving the medial collateral ligament. In this study we compare 2D spin echo (SE) MR scans with a 3D spoiled gradient recalled echo (SPGR) acquisition of the ankle and score them for ligaments visualized. 12 ankles from six healthy volunteers (three men, three women) of average age 30.5 years (range 21–38) were studied. 2D SE (TR 600 ms, TE 20 ms) 5 mm thick slices in sagittal, coronal and axial planes (acquisition time 11 min) and 3D SPGR (TR 50 ms, TE 12 ms, flip angle 45°) 1.5 mm sagittal images (acquisition time 6 min) of both ankles were obtained and scored by two radiologists independently for visualization of 10 major ligaments (0 = not seen, 1 = just seen, 2 = well seen). In multiplanar 2D SE sequences 76% of ligaments were seen (mean score 0.79). On orthogonal reconstruction from 3D SPGR images, 87% of ligaments were visualized (mean score 0.93) and with additional oblique reconstructions 100% of ligaments were visualized (mean score 1.74). We conclude that 3D SPGR acquisition with oblique reconstruction offers diagnostic capability beyond that provided by 2D SE images as it enables data to be viewed in optimal plane and therefore has potential for routine application in diagnosing tears of ankle ligaments.

11.50 – 11.58 am

MRI diagnosis of acetabular labral tears: correlation with conventional arthrography [Paper]

K H Lakin, M K Benson, D J Wilson and S J Ostlere
Departments of Radiology and Orthopaedic Surgery, Nuffield Orthopaedic Centre NHS Trust, Headington, Oxford OX3 7LD, UK

This study compares magnetic resonance imaging (MRI) and single contrast arthrography in the assessment of the acetabular labrum in adult patients with congenital dysplasia of the hip. Eight patients were examined by single contrast arthrography and MRI using a Helmholtz coil on a 1 T system (Siemens Magnetom). T_1 weighted spin echo and T_2 weighted gradient echo coronal images were obtained. The investigations were assessed by two experienced musculoskeletal radiologists. In seven patients (four with labral tears and three with intact labra) there was agreement between arthrography and MRI. One patient was considered to have a possible labral tear on MRI evidence, although the labrum appeared intact on arthrography and at surgery. We conclude that MRI is a potentially useful method for assessing the integrity of the acetabular labrum. Abnormalities of the labrum are particularly well shown on T_2 weighted gradient echo coronal images.

11.58 am – 12.06 pm

MRI in complex orbital trauma [Paper]

[1]J Kabala, [1]P Goddard, [3]G Putnam, [2]M Voltruba, [2]M Potts, [2]R Harrad and [3]P Ward-Booth
Departments of [1]Clinical Radiology, [2]Ophthalmology and [3]Oro-facio-maxillary Surgery, United Bristol Healthcare Trust, Bristol, UK

Trauma to the orbit has potentially serious immediate and delayed complications. Accurate assessment of the injury (traditionally by CT) is important in planning management. This however is limited where artefact arises from dense intra-orbital foreign bodies (IOFBs) and where the soft tissue component of the problem is important. In such cases MRI has major theoretical advantages. MRI was used with six patients for whom conventional imaging methods had failed to answer the clinicians' questions completely: two with IOFBs whose CT images were degraded by artefact from the lead pellet so that the location was uncertain; one with disruption of the globe in whom the possibility of posterior extravasation of uveal material was a concern; and three with orbital floor trauma (two treated with orbital floor implants) in whom recurrent orbital swelling/proptosis was a problem. Turbo-spin echo sequences were performed (transverse multi-echo, coronal STIR and T_1 weighted sequences) through the orbits on a 1 T Siemens Magnetom. Care was taken to move the patients with the intra-ocular foreign bodies slowly into the scanner, and no fast scans were obtained. The IOFBs were located. Accurate delineation of the globe damage (three cases) and extent of bone defect, oedema and inflammation (three cases) was achieved. In complex orbital trauma MRI is proving to be extremely useful, and with care, intra-ocular foreign bodies and the need to demonstrate bone defects are not proving to be problems.

10.45 am – 12.00 noon

Teach-in: High Resolution CT of the Chest

Ripley Suite

10.45 – 12.00 am
The role of high resolution computed tomography in the management of diffuse infiltrative lung disease
[Invited Review]
C D R Flower and F Gleeson
Departments of Diagnostic Radiology, Addenbrooke's Hospital, Cambridge and The Churchill Hospital, Oxford, UK

High resolution computed tomography (HRCT) consists of a series of thin slices performed using a high spatial frequency reconstruction algorithm. The technique has been available for several years and is used to assess patients with chronic infiltrative lung disease, emphysema, bronchiectasis and some acute lung diseases. In these talks we will review the technique of HRCT, describe the patterns of abnormality commonly seen in a collection of diffuse lung diseases, and discuss the appropriate use of HRCT within the clinical setting.

10.45 am – 12.11 pm

Radiological History

Bramham Suite

10.45 – 11.10 am
A history of the early years of radiotherapy with emphasis on X-ray and radium apparatus
[Invited Review]
R F Mould
South Croydon, Surrey CR2 0ED, UK

Radiotherapy using X-rays was attempted soon after Röntgen's discovery, prompted by observations of the depilatory effect of the rays, but such therapy was not then limited only to cancers and many cases were treated for non-malignant conditions: some just for cosmetic purposes. However, at the turn of the century proven successful treatments of epithelioma were documented: usually by dermatologists. A similar experience followed Marie Curie's discovery of radium in 1898 with many benign lesions receiving radium treatment and with some rather bizarre therapeutic applications being recommended. The first successful radium treatment of cancer was in 1903, the same year in which the principle of afterloading was suggested. The equipment of these early days makes fascinating viewing and, for X-rays, a selection will be shown including completely unprotected apparatus used to treat breast cancer, Holfelder X-ray cannons and the then method of patient positioning, Sabouraud & Noire pastilles used for early dosimetry, and the results of treatment planning before 1920. Regarding radium, some of the plaques and facial moulds used to treat surface lesions must have appeared terrifying to the patient, radium implant radiographs show that a very large number of sources were used for a single patient, and there is an interesting spectrum of applicator designs. For the teleradium bombs which preceded telecobalt machines there were many varied designs, from some of which the low radiation output can be guessed at since the patients are shown in the treatment position reading books and newspapers and smoking cigarettes! Water phantoms for isodose measurement were in existence in the 1920s but must have given the physicists a rather difficult life from the experimental arrangements at that time. Photographs of patients treated circa 1905, shown before and after treatment, will be presented as will some radiation protection apparatus.

Reference
MOULD, R F, *A Century of X-rays and Radioactivity in Medicine with Emphasis on Photographic Records of the Early Years* (Institute of Physics Publishing, Bristol) (1993).

11.10 – 11.35 am
The work of the Deutsches Roentgen-Museum
[Invited Review]
U Hennig
Deutsches Roentgen-Museum, D-42897 Remscheid, Germany

The "Deutsches Roentgen-Museum", situated in Remscheid-Lennep, the birthplace of Wilheim Conrad Roentgen, is a Museum of Science and Technology. It presents a collection of apparatus used to produce and apply X-rays and is unique throughout the world. Nowadays Roentgen physics is — in contrast with most other scientific fields — closely related to many other areas such as physics, medicine, technology and the arts. The Museum has assumed the task of documenting the research work of W C Roentgen and of presenting the entire topic in a way which is comprehensible even to the interested layman. But it is the expert who also finds the opportunity here to gain a deeper insight into the history of X-rays and their application. These studies can be completed by the use of the special reference library equipped with works about Roentgen physics, Roentgen technology and Roentgen medicine, which is situated in Roentgen's birthplace. The Deutsches Roentgen-Museum as a so-called working museum has installed an "Experimental Laboratory" in order to arouse public interest in science and technology, especially amongst the young. Anybody who wants to carry out simple physical experiments is welcome. Another project called "Radioactivity and X-rays"

offers experimental lessons to school classes on the Museum premises. It is the awarding of the Roentgen plaque presented by our Lord Mayor which is the annual highlight in the everyday life of the Museum. This highly regarded scientific award has been granted to outstanding scientists from all over the world, including British scientists.

11.35 – 11.39 am
The BMUS Historical Collection: why, what, which, where, who, when [Poster]
J E E Fleming
Department of Obstetrics & Gynaecology, University of Glasgow, Glasgow G3 8SH, UK

The British Medical Ultrasound Society Historical Collection started in 1984 as part of BMUS's educational programme. The aim is to collect, document, preserve, exhibit, and interpret material evidence and associated information for the benefit of the Society and the public. The scope of the collection is material relating to diagnosis and therapy designed, made, or used in the UK. It contains material from 1955 onwards, including ultrasound instruments (whole or part), transducers, specialized test equipment; ultrasound images, films, videotapes and audiotapes; photographs of instruments and people; manufacturers' manuals, pamphlets, specifications, and commercial documents; personal accounts, letters, manuscripts, original copies of papers and historical reviews and interpretations. The collection will go to The Hunterian Museum (University of Glasgow) where facilities exist for its long-term preservation. It is available for study or exhibition: please apply to the Historical Collection Coordinator, Mr J E E Fleming, or the BMUS General Secretary, 36 Portland Place, London W1N 3DG.

11.39 – 11.47 am
The new photography: photographic contributions to the early development of diagnostic radiology [Paper]
J M Guy
Newtown, Powys SY16 3DS, UK

Various technologies combined to make possible the discovery of X-rays in 1895—glass manufacture, vacuum production, electricity generation. While not essential to the production of X-rays, photographic recording was instrumental in distributing knowledge of the discovery and in the development of radiodiagnostic technique. Nevertheless, a large amount of diagnostic work before the first World War was performed by fluoroscopy. Dry plate photography was still a recent development in 1896. Some film had been produced but was not widely used in radiography in Britain until after the First World War. The theory of fluorescence and intensifying screens was known in 1896, but application to routine radiography was slow, because of the graininess of films produced. Photographers were notable among the pioneer radiographers.

11.47 – 11.55 am
A brief history of gastrointestinal imaging [Paper]
A K Banerjee
Department of Radiology, St Thomas' Hospital, London SE1 7EH, UK

The first X-ray of the gastrointestinal tract was produced by Lindemann in Hamburg in 1897. The real breakthrough came with the discovery of bismuth as a contrast agent. Pfahler in Philadelphia noted in 1897 that a photographic plate of a patient's abdomen contained bismuth in the stomach (bismuth was used for treating ulcers). Advances in the physiology of the stomach were made by Cannon, then a physiology student at Harvard. He studied gastric movements in adults and children. In Germany in 1904 Rieder published a paper on the bismuth meal, advocating rapid serial filming (a forerunner of the barium meal). In Vienna, Hotzknecht was advocating fluoroscopic examination of the gastrointestinal tract. In the USA, Russell Carman of the Mayo Clinic built up a vast experience using fluoroscopy and also wrote the first textbook on gastrointestinal imaging. Pioneers in Britain included A E Barclay, who used a combination of screen and plate methods. The first contrast examination of the large bowel was performed by Schule in 1904. Double contrast examinations were reported in 1921 from Sweden and, following several papers from Malmo by Welin, the technique was brought to use in St Mark's Hospital, London by Young.

11.55 am – 12.03 pm
Groby Road Hospital—a celebration [Paper]
N Hudson, R Keal, C Reek and J Walker
X-ray Department, Groby Road Hospital, Groby Road, Leicester LE3 9QE, UK

The foundation stone of Groby Road Hospital was laid on 28 March 1899 as the Borough of Leicester Isolation Hospital. In those days this was a green field site 3 miles

northwest of the city centre. During the 1930s the TB sanatorium for the city was built in the grounds and with this came thoracic surgery. Cardiac surgery followed in the 1950s and in the mid 1960s the hospital became the sub-regional cardiothoracic unit for the East Midlands. Today it has become one of the largest cardiothoracic units in the country with an international reputation. In January 1994 the hospital closed and moved to a new site 400 yards further up Groby Road. Radiological services have been provided on-site since the 1930s, and with the development in the 1960s came full cardiac investigation facilities. There has always been close radiology involvement, unusual for a "stand alone" cardiothoracic unit, and there are now three cardiac radiologists. It is one of the few centres approved by the Royal College of Radiologists for post-fellowship training in cardiac radiology. The talk illustrates the history of Groby Road Hospital with emphasis on the radiological facilities and expertise available during its history.

12.03 – 12.11 pm

Dr S Gilbert Scott and wide field therapy [Paper]

A M K Thomas

Department of Radiology, Bromley Hospital, Bromley BR2 9AJ, UK

Dr Sebastian Gilbert Scott (1879–1941) was a major figure in British radiology in the inter-war years and has not had the attention that he deserves. He qualified in medicine in 1904 and became radiologist to the London Hospital, retiring from hospital practice in 1930. His interests were numerous and he made advances in many areas, including the diagnosis and therapy of rheumatic diseases, gastrointestinal radiology, radiation protection and medical jurisprudence. Of particular interest is his use of wide field X-ray therapy (the X-ray bath), which was described in his Mackenzie-Davidson Memorial Lecture of 1937. In this presentation his lasting contribution will be assessed.

12.15 – 1.15 pm

3M Mayneord Memorial Lecture

Royal Hall

Image processing and mammography [Eponymous Lecture]

M Brady
Department of Engineering Science, University of Oxford, Parks Road, Oxford OX1 3PJ, UK

Considered as images, X-ray mammograms leave a great deal to be desired: they are noisy, give poor contrast, and are large and highly textured. This poses a huge challenge for image processing, one that is compounded by the need for radiologists to have confidence in the images presented to them. An error rate of just 0.1% corresponds to 300 breasts annually. We have developed a computational model of the X-ray process and used this to develop a workstation for radiologists. Other work explores the application of neural network recognizers to locate clinically significant signs in X-ray mammograms.

2.15 – 4.40 pm

The Breast

Harewood Suites I & II

2.15 – 2.40 pm
Mammography physics: achievements and problems [Invited Review]
J Law
Department of Medical Physics and Medical Engineering, Western General Hospital, Crewe Road, Edinburgh, EH4 2XU, UK

A brief review will be given of physics aspects of the present performance of mammographic X-ray sets and associated equipment, and of the appropriate test equipment. This review will extend to X-ray film, screens, cassettes and processing. Current problems will be outlined and possible future developments indicated.

2.40 – 2.48 pm
Imaging performance of storage phosphor digital mammography. A preliminary experimental and clinical study [Paper]
J Hildell
Department of Radiology, King Faisal Specialist Hospital and Research Centre, Riyadh 11211, Saudi Arabia

To evaluate whether storage phosphor digital mammography (DM) can be as accurate for breast imaging as film–screen mammography (FM), DM was compared with FM in one experimental and one clinical study. The experimental study employed a test phantom (SIB) from which an image quality score (IQS) could be derived, and a mastectomy specimen with superimposed "microcalcifications". The clinical study comprised 1200 women examined with DM as well as with FM. It was found that: (1) detail visualization of DM was highly dependent on proper image processing; (2) IQS of DM was equal to IQS of FM at 25 kVp and mAs > 160; (3) optimal image quality on DM required the same dose for DM as for FM; (4) FM was slightly superior to DM in demonstrating microcalcifications smaller than 0.3 mm; (5) clusters of microcalcifications were demonstrated with the same accuracy by both methods; (6) visibility of details of breast parenchyma was the same with both methods; and (7) DM was slightly superior to FM for evaluation of dense breasts, skin and subcutaneous tissue. The results of this study suggest that DM, with lower spatial resolution than FM, may well be used for breast imaging, provided the mammograms are properly processed.

2.48 – 2.52 pm
Fluorescent screens for mammography [Poster]
[1]G E Giakoumakis and [2]G S Panayiotakis
[1]Physics Department, University of Ioannina, 451 10 Ioannina and [2]Medical Physics Department, University of Patras, 265 00 Patras, Greece

We report on the properties and characteristics of X-ray phosphor screens prepared by different methods (including sedimentation, evaporation and electrophoresis) from various inorganic phosphor materials. Measurements and evaluations are focused on the dependence of absolute efficiency and of modulation transfer function on the tube's voltage and the screen's thickness. Conditions of measurements (tube voltage, filtration, modes of observation, etc) are the same, or nearly the same, as those used in mammography. A number of older materials already in commercial use and four new ones have been investigated. Results and comparisons are given in the form of figures and tables. Appropriate theoretical models and simulation techniques have been used for the estimation of intrinsic parameters of materials. Some of the new phosphors show very promising properties, especially in respect to their efficiency and spectral distribution of emission.

2.52 – 2.56 pm
Radiation dose reduction in mammography—is there a limit? [Poster]
H Fenlon, F Flanagan, O Laird, G Dowsett and J Ennis
Department of Radiology, University College of Dublin, Institute of Radiological Sciences, Mater Misericordiae Hospital, 52 Eccles Street, Dublin 7, Ireland

Minimizing radiation dose to the patient is of prime importance, particularly in breast screening. Newer K-edge filters and rare earth screens reduce radiation dose and also reduce the degree of image degradation owing to scatter.

Grid technology has remained unchanged. This study redefines the role of the grid in modern mammography. Initial studies of phantom test objects, imaged both with and without a grid, suggested that complete removal of the grid caused less image degradation than expected. 50 patients having diagnostic mammography had a single view repeated following removal of the grid. The set of grid and non-grid images were compared by three radiologists, using a number of normal and abnormal features. Densitometric analysis was performed on each set to assess the contrast quantitatively. Overall, little image degradation resulted from complete removal of the grid: 90% showed no diagnostic difference. The dose for the non-grid images was one-third of the standard dose. The present designs of grids do not take advantage of the reduced scatter load in modern mammography, and contribute significantly to increase the dose. Re-evaluating grid design would therefore allow quality images to be produced at a reduced dose.

2.56 – 3.04 pm

Comparison of quantitative dynamic MR mammography and quantitative colour Doppler ultrasound in breast lesions of unclear dignity [Paper]

A Mundinger, H Madjar, S Kaminsky, J Laubenberger, X Papacharalampous, M Klink, A Pfleiderer and M Langer

Department of Diagnostic Radiology, University of Freiburg, 79106 Freiburg, Germany

We designed a controlled prospective study to compare the diagnostic value of quantitative dynamic MR mammography (MRM) and quantitative colour Doppler ultrasound in patients with breast lesions of unclear dignity. Both quantitative dynamic MR mammography and colour Doppler ultrasound assessing total flow (sum of flow velocities of all tumour vessels) were performed in 50 patients showing suspicious clinical, sonographic or mammographic signs. The dynamic MR study was obtained using multislice FLASH sequences (200/4/70°) before and every 30 s after the injection of 0.1 mmol kg^{-1} Gd DTPA. Cut-off point for the diagnosis of malignant lesions was set at > 180% increase of MR signal intensity and a total flow of > 60 cm s^{-1} in Doppler ultrasound. Final diagnosis was confirmed by histology or cytology. All cases of invasive breast cancer were diagnosed by both methods. Sensitivity of quantitative MRM and colour Doppler was 90%. MRM, however, showed a higher specificity (95% *versus* 85%). False positive Doppler results in proliferative mastopathy and false negative MRM results in non-invasive carcinoma impaired the diagnostic performance. We concluded that dynamic quantitative MRM is the non-invasive method of choice for further diagnostic work-up of suspicious breast lesions as it is more specific than colour Doppler ultrasound.

3.04 – 3.12 pm

A Norwegian national interlaboratory comparison of image quality and total performance in mammography [Paper]

[1]J B Olsen, [2]A Widmark, [2]H Fosmark, [1]A Skretting and [3]E M Sager

[1]Department of Medical Physics and Technology, The Norwegian Radium Hospital, N-0310 Oslo, [2]National Institute of Radiation Hygiene, N-1345 Østerås, and [3]Department of Radiology, The City Hospital of Oslo, Ullevål, N-0407 Oslo, Norway

The main purpose of this interlaboratory survey was to compare total performance and image quality in all Norwegian mammography laboratories, and to relate the results to technical parameters measured on site. Total performance was measured with a mammography phantom composed of exchangeable blocks of breast tissue, overlay plates containing structures that simulate microcalcifications (with various diameters and different densities), a step wedge and a surrounding piece of Perspex formed as a compressed breast. Radiologists of each laboratory read the images and reported the findings from 80 image regions in a way that enabled a ROC analysis to be performed. Images of a breast tissue phantom and two commercially available phantoms were used by reference groups to subjectively assess image quality. In addition, a comprehensive set of technical parameters was measured. The results show that the image quality in general was satisfactory. Reading of the images of the total performance phantom was well accepted by the radiologists. In some cases, there was a striking lack of correlation between technical parameters and the results of the total performance test. Because of the similarity with clinical practice, the application of the total performance phantom is a reliable means for quality assurance in mammography.

3.12 – 3.20 pm

Radiological audit of the incident round breast biopsies from the Greater Manchester Breast Screening Service [Paper]

C R M Boggis, M Wilson and D L Asbury

X-ray Department, Withington Hospital, Manchester M20 0PT, UK

This audit is a review of radiology and pathology of incident biopsies from the Manchester Breast Screening Service. New or changed mammographic findings comprised calcifications, masses, asymmetry and distortion,

and occurred in 95 women. Calcifications were found in 42 (44%) women: benign in 10 and malignant in 32. These calcifications were new in seven (37%) of benign and 26 (34%) of malignant biopsies and increased in three (16%) and six (7%) respectively. New mass lesions occurred in 55 women: 51 were malignant, of which five were ductal carcinoma *in-situ* (DCIS), and four were benign. Increased size of masses was seen in one malignant and five benign biopsies, the latter comprising fibrocystic change and one complex sclerosing lesion. Asymmetry was found in eight (8%) women: malignant in seven and benign in one. Distortion developed in 15 (16%) women and increased in one, all found to be malignant on biopsy. In the 95 biopsies, 76 (80%) were malignant, 60 invasive and 16 DCIS, and 19 (20%) were benign: malignant to benign ratio = 4:1. In general, the dominant radiological features of incident tumours are masses (65%) and calcifications (42%), found together in 11% of cases. Mammographic calcifications are found more frequently in DCIS: 50% were in the 16 biopsies for DCIS. New distortion and asymmetry were less frequent but when present are highly significant features almost always indicating malignancy.

3.20 – 3.28 pm
Stereotactic localization of small breast lesions for diagnosis and preoperative marking—method, experimental procedures and clinical results in 275 patients [Paper]
R Schulz-Wendtland, M Bauer, S Krämer and A Büttner
Department of Gynaecological Radiology, University of Erlangen, Universitätsstr. 21/23, 91054 Erlangen, Germany

Between November 1987 and November 1992, 275 stereotactic examinations of the breast were performed in the Breast Clinic of the University of Freiburg and Erlangen, including 194 stereotactic biopsies and 81 localizations. Indications were: localizations of lesions which were only visible in one plane on mammography, preoperative definition of lesions which could be recognized only by mammography, cytological confirmation of benign lesions, and preoperative cytological confirmation of malignant lesions before carrying out conservative resections. Cytological diagnosis was possible in 127 patients (65%) (1988—26%; 1989—67%; 1990—74%; 1991—79%; and up to November 1992—80%). All carcinomas diagnosed cytologically were confirmed histologically (13 cases with a diameter up to 5 mm). Comparison of the preoperative diagnosis (81 cases) with histological findings showed a high proportion of grades 2 and 3 proliferative breast disease and papillomas (45 patients, 81%). The advantages and disadvantages of the method for diagnosing breast disease are discussed.

3.28 – 3.32 pm
Comparison of fine needle aspiration and wide core needle biopsy in a breast screening unit [Poster]
M A Crotch-Harvey, C F Loughran and P K Sinclair
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Sampling inadequacy at fine needle aspiration cytology (FNAC) is common. To help overcome this we elected to undertake supplementary wide core needle biopsy (WCNB), using a rapid-firing automated biopsy device (Biopty) at the same examination. 89 women from the prevalent round of the breast screening programme with 94 non-palpable mammographic abnormalities underwent the combined procedure. 34 women later underwent surgical biopsy, of whom 27 were shown to have carcinoma. The sensitivity for detection of carcinoma at FNAC was 52% and at WCNB 63%. This increased to 74% (20/27) when the results from the separate procedures were combined. The specificity for exclusion of carcinoma at FNAC was 49%, for WCNB 82%, and for the combined procedure 85%. No complications occurred as a consequence of the additional biopsy procedure.

3.32 – 3.40 pm
High-speed core biopsy: a new method for histological diagnosis of indistinct breast lesions [Paper]
M Bauer, R Schulz-Wendtland, A Büttner and S Krämer
Department of Gynaecological Radiology, University of Erlangen, Universitätsstr. 21/23, 91054 Erlangen, Germany

From April 1990 until November 1992 high-speed core biopsies were performed on 248 patients; 192 needed additional surgery for histological diagnosis. The indications for a core biopsy were palpable, mammographic and sonographic indistinct benign or suspect lesions. The aim of the study was to investigate the validity of the histology of the core biopsy and to correlate it with the final surgical histology. Criteria of evaluation were the accuracy of the core biopsy, dependent on the tumour size, histology, and needle size. The sensitivity of this method was 98.1%, specificity 94.1%. The positive predictive value was 98.4%, the negative predictive value 94.1%. The tumour size had no influence. During the study period different needle sizes (1.2G; 1.6G; 2.1G) were tested—1.2G needle samples did not give as good histological results as the bigger ones. High-speed core biopsies, documented by ultrasound and also performed stereotactically, proved a success in clinical routine.

3.40 – 3.48 pm

Stereotactic large-core needle biopsies of breast lesions: a report of 400 cases [Paper]

M Hardjasudarma, G Walker, F Abreo, M Schwalke, J Lecky, M Walker and M Wood

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We studied the advantages and disadvantages of stereotactic breast biopsies, particularly as compared with surgical biopsies, from 400 consecutive cases biopsied on a dedicated stereotactic unit, with a biopsy gun and 20, 18, 16 and 14-gauge needles. A selected subset had further surgical biopsies. The results of the two types of biopsies were compared. The large-core biopsy needles gave the best results, and we now use 14G needles exclusively. Comparison of the two types of biopsies showed no false negatives, and very few false positives (for malignancy) with the needle biopsies. The positive predictive value with the 14G needles was > 90%. We concluded that stereotactic large-core needle biopsy is an acceptable alternative to surgical biopsy. When the result indicates a benign lesion, no further work-up is necessary. Mammographically malignant lesions may still benefit, since the result may aid in outlining the surgical plan.

3.48 –3.56 pm

Influence of number of cases referred for biopsy on positive predictive value for abnormalities detected on breast screening [Paper]

M J Michell, S Moritz and S Humphreys

South East Thames Breast Screening Quality Assurance Reference Centre, King's College Hospital, London SE5 9RS, UK

The positive predictive value (PPV%) for malignancy following assessment is an important measure of the quality of radiological performance in breast screening. A study has been conducted to explore the relationship between radiological performance and number of cases examined. Assessment data has been recorded on the S.E.T. Breast Screening QA Database for all patients undergoing surgical biopsy for screening-detected abnormalities, together with details of the final histology. The data for 1980 cases seen between June 1988 and December 1992 has been analysed to assess change in PPV% for individual radiologists, related to time and the number of cases assessed. The mean PPV% increased significantly ($p = 0.005$) during the first screening round from 59 in year one to 76 in year three. The PPV% for non-palpable lesions increased from 45 to 66 and for palpable lesions from 74 to 86. Analysis of the PPV% for individual radiologists for batches of 20 cases shows a strong correlation ($r = 0.66$) between the number of cases assessed and the PPV%. Although the increased availability of fine needle aspiration cytology may contribute to this improvement, the results suggest that with increased experience, radiologists improve their interpretive ability and are more likely to achieve a high PPV%.

3.56 – 4.04 pm

Features of breast carcinoma detected from early recall in a screening population [Paper]

M E Warren and J Cooke

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A retrospective review was conducted of mammographic, clinical, sonographic, cytological and histological findings in all cases of early recall cancers passing through the Surrey Breast Screening Programme over a 2-year period, to determine any specific features which might have led to earlier diagnosis. From January 1990 to December 1991, 65 897 women attended for screening; 5420 were recalled for assessment and 479 were referred for surgical biopsy, yielding 380 carcinoma and 88 benign lesions (11 cases were kept under specialist review). During this time 330 women were placed on early recall, of whom 14 were subsequently referred for biopsy, yielding 12 carcinomas and two benign papillomas. Uncertainty regarding calcification was the most frequent mammographic finding leading to early review (60%). Of the 14 cases referred at early review, 13 were initially recalled for calcification. The initial mammographic features and subsequent changes at re-evaluation will be discussed. Analysis shows that of the 12 that were subsequently diagnosed as cancer, five had subtle changes, six more suspicious mammographic findings and one was observer oversight. We shall present recommendations for assessment protocol to minimize early review cases and to improve decision-making at initial assessment.

4.04 – 4.12 pm

Short-term recall for "probably benign" mammographic lesions detected in a 3-yearly breast screening programme [Paper]

J S Dawson and A R M Wilson

Department of Radiology, Breast Screening Training Centre, City Hospital, Nottingham NG5 1PB, UK

The outcome of short-term recall for the follow-up of "probably benign" non-palpable mammographic lesions which were screen-detected over a 4 year period is presented. Patients selected for short-term recall underwent further ipsilateral mammography 1 year later. Progression in the mammographic appearance in the interval prompted

excision biopsy; if there had been no change, the patient was discharged back to the normal screening protocol. Of 35671 asymptomatic women screened between 1988 and 1992, 1762 (5%) attended an assessment clinic. Thereafter 131 women (7% assessed, 0.4% screened) (age range 50 67 years) were put on short-term recall and were reviewed between 1989 and 1993. The "probably benign" lesions were: calcifications (91 cases, 69%); circumscribed density (18 cases, 14%); parenchymal deformity/stellate density (13 cases, 10%) and asymmetric breast tissue (9 cases, 7%). 128/131 women attended for short-term recall (compliance 98%): five of these were given excision biopsies, identifying three invasive carcinomas and two ductal carcinomas-*in-situ*. The largest carcinoma measured 15 mm and none of the tumours demonstrated vascular invasion or axillary metastases, so that their prognosis was favourable. The positive predictive values were: calcifications 3.3%; circumscribed density 0%; parenchymal deformity/stellate density 15.4% and asymmetric breast tissue 0%. We conclude that short-term recall is a reasonable management option for a small number of women with "probably benign" calcifications. Parenchymal deformity and stellate densities should probably not be managed by this approach, and require excision after initial assessment. Circumscribed densities and asymmetric breast tissue can be safely discharged following assessment.

4.12 – 4.16 pm

The imaging features of ductal adenoma of the breast, with cytopathological correlation [Poster]

E Hurley, F E White and L S Turnbull
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The purpose of this study was to determine the imaging characteristics of ductal adenoma of the breast, which to date have not been well described, and to review the cytology in relation to the histological features. The mammograms of six cases (age 47–61 years) detected through the National Breast Screening Programme were reviewed, and the presence of a mass, stromal deformity, calcification and background parenchymal pattern were recorded. Four patients also had ultrasound scans. The radiographs were graded 1 to 5 in terms of radiological suspicion of malignancy. Imaging appearances were correlated with cytology and histology. An ill-defined mass of intermediate to high density, associated with a combination of microcalcification and coarse calcification, was the most common mammographic appearance. Stromal deformity was not seen. Ultrasound usually demonstrated a heterogeneous ill-defined mass with variable posterior attenuation. All cases underwent fine needle aspiration, with reports ranging from C3 to C5. Histological examination showed ductal adenoma in all cases, often associated with benign breast change. We have described the imaging characteristics of ductal adenoma, an important diagnosis to be aware of as it can mimic carcinoma clinically and radiologically. The confusing cytological features may lead to problems in diagnosis and management.

4.16 – 4.24 pm

Radial scars associated with a high incidence of carcinoma or atypical hyperplasia [Paper]

I D Morrison, C A Wells, R Carpenter and N M Perry
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There has been considerable debate as to whether radial scars are benign lesions, markers for increased risk of breast carcinoma, or even incipient tubular carcinomas. We present a review of the radiology, cytology and histology of the 46 radial scars on our records. Carcinoma was associated in 16 out of 46 cases (35%), half of these being *in situ*. In addition, a further nine cases showed atypical hyperplasia (19.5%), contrasting with the lower overall incidence in our screening service, 9.3%, of atypical hyperplasia in benign biopsies without radial scar. These results indicate that radial scars are associated with a significantly increased incidence of carcinoma and atypical hyperplasia. The difficulty in distinguishing simple from complicated radial scars on the basis of their radiological appearances is highlighted. We conclude that lesions detected on mammography which show features suggestive of a radial scar should be removed, due to the high risk of development of malignancy.

4.24 – 4.32 pm

Hormone replacement therapy and mammographic background pattern [Paper]

P N M Tyrrell and M G Wallis
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Small studies have reported that hormone replacement therapy (HRT) halts or even reverses the normal involutional change in breast density that occurs with increasing age. The aim of this study was to test this hypothesis in a large group of women attending for breast screening. 300 women and 600 age-matched controls were recruited from the second-round screen, *i.e.* those who had commenced HRT since the first screen. 334 women on named preparations were subsequently recruited. We found that HRT leads to an increase in background density in 11% of subjects compared to 0.8% of controls. This does not appear to be related to duration of HRT, and is more likely

to occur in dense and dense-fatty breasts. Decreasing density was similar in both study (5.3%) and control (6.2%) groups. Combined preparations are more likely to show a change in density than oestrogen alone (11% *vs* 7%). The fact that HRT is associated with an increase in background density without an apparent effect on involution suggests the possibility of an active process rather than a possible block.

4.32 – 4.36 pm

The radiological appearances of invasive cribriform carcinoma of the breast [Poster]

J A Stutz, S Pinder, I O Ellis, A R M Wilson, L J Yeoman and A J Evans

Departments of Radiology and Pathology, City Hospital, Hucknall Road, Nottingham NG5 1PB, UK

Invasive cribriform carcinoma is a variant of tubular carcinoma characterized by a cribriform rather than a tubular architecture. It is rare, accounting for 0.6% of breast cancers in Nottingham, and has an excellent prognosis. As far as we are aware, its radiological features have not previously been described. Preoperative mammograms were available in eight cases (6 symptomatic, two detected on screen) and preoperative ultrasound examinations in four cases. The tumour was mammographically occult in 4 (50%) cases. The four tumours visible on mammography showed as a large (20–35 mm) spiculated mass, and two contained a few flecks of punctate calcification. The tumours did not show ultrasound appearances considered typical of breast carcinoma. Although 3/4 showed an ill-defined inhomogeneous solid mass, no marked distal acoustic attenuation was seen. Three cases showed no distal characteristics, and one case showed mixed distal acoustic attenuation and enhancement. Three cases showed an echogenic halo. The imaging characteristics of invasive cribriform carcinoma appear to be different from those of tubular carcinoma, which classically presents mammographically as a parenchymal deformity, and ultrasonically as a inhomogeneous attenuating mass.

4.36 –4.40 pm

Is ipsilateral mammography worthwhile in patients with Paget's disease of the breast? [Poster]

A Ceccherini, S Pinder, A R M Wilson, I O Ellis, L J Yeoman, R W Blamey and A J Evans

Departments of Radiology, Surgery and Pathology, City Hospital, Hucknall Road, Nottingham, NG5 1PB, UK

This study aims to identify the clinical value of preoperative ipsilateral mammography in patients with Paget's disease. Preoperative mammograms were available in 27 patients. 44% were normal mammograms. Mammography did not discriminate between invasive disease ($n = 5$) and ductal carcinoma *in situ* (DCIS). There was no difference in the DCIS subtype mix of those with normal or abnormal mammography. Comparing the mammographic features of DCIS in patients with Paget's disease and those of symptomatic patients without Paget's disease, normal mammography was found to be more common in the Paget's group: 10/22 (44%) *vs* 11/49 (22%), $p < 0.05$. When comparing the pathological features of DCIS in patients with and without Paget's disease, large cell solid disease was more common (4/22 *vs* 2/58, $p < 0.05$) and small cell cribriform disease less common (0/22 *vs* 14/46, $p < 0.05$) in the Paget's group. In our unit, treatment of Paget's disease consists of simple mastectomy. Lymph node sampling is performed at a later date only if invasive disease is present. In these circumstances the only benefit of ipsilateral mammography would be to allow image guided core biopsy of detected abnormalities. If invasive disease is shown, node sampling could be performed at the time of the mastectomy. Ipsilateral mammography appears to have only a very limited role in the management of Paget's disease.

2.15 – 3.15 pm

Gastrointestinal Imaging

Ripley Suite

2.15 – 2.19 pm

The ultrasound features of choledocholithiasis [Poster]

B J Abdullah and J Rawlinson
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An ultrasound diagnosis of gallbladder calculi is usually straightforward and depends on seeing mobile echogenic foci within the lumen which cast acoustic shadows. The detection of choledocholithiasis can be difficult, with reported detection rates ranging from 13 to 75%. One reason for this is that the classic ultrasonic signs normally associated with gallbladder calculi are not always present. We have reviewed the ultrasonic features of 45 common bile duct (CBD) calculi diagnosed by ultrasound in 29 patients, all of which were confirmed by endoscopic retrograde cholangiography, to identify these atypical features and document their incidence. Only 30 of the calculi (67%) were depicted by the ultrasound beam as having an echogenic leading surface. Acoustic shadowing was not seen beyond nine (20%) of the calculi. A convex proximal margin to the calculus complex was present in 21 patients (72%). A convex distal margin was seen in 16 patients (55%). Dilatation of the CBD (> 6 mm) was present in 28 patients (97%) and intrahepatic duct dilatation in 15 (52%). Several examples of choledocholithiasis are presented on this poster, selected to illustrate typical and atypical features of the condition.

2.19 – 2.27 pm

MRI in perianal disease—an effective tool [Paper]

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Departments of [1]Radiology and [2]Surgery, Queen Elizabeth Hospital, Birmingham B15 2TH, UK

MRI is emerging as the best form of imaging for investigating complex perianal disease. Frequency-selected fat suppressed T_2 weighted spin echo MR imaging is particularly useful in identifying the tract, and T_1 weighted images give a clear demonstration of anatomy and internal opening. To illustrate this, we present three cases with perianal disease where MRI clearly showed the abnormalities which were confirmed during surgery. Case 1 had an 18-month history of anal fistula following an ischiorectal abscess. Surgery revealed an internal opening at the anorectal junction and a tract feeding the ischiorectal fossa cavity. Case 2 was a delayed presentation of ischiorectal abscess, requiring defunctioning ileostomy and drainage of pelvic and perianal abscess with a resultant perianal sinus. A tract with no communication was found on surgery. Case 3 had had perianal problems since 1982 with many previous operations. Surgery confirmed the presence of multiple tracts and abscess cavities seen on MRI with the internal opening above the puborectalis. In all three cases MRI was superior to clinical assessment and was helpful prior to surgery by demonstrating the number of tracts and the internal opening.

2.27 – 2.35 pm

Proctographic changes following rectopexy for SRUS and preoperative predictive factors for a successful outcome [Paper]

S Halligan and C I Bartram
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Rectopexy (presacral rectal fixation) is the operative treatment of choice for solitary rectal ulcer syndrome (SRUS). However, outcome is variable. 23 patients with proven SRUS underwent evacuation proctography (EP) before and after operation to demonstrate the effects of rectopexy and determine predictive factors for successful outcome. EP was performed using 120 ml of intrarectal barium paste with lateral video fluoroscopy and computerized video capture for image analysis. Parameters measured included: evacuation time/completeness (by planimetry), rectal axis from vertical and pelvic floor descent (PFD) at rest/evacuation. After rectopexy, patients were divided into two groups: improved or not; and the EP measurements compared. Intussusception, which was found in 19/23 (83%) preoperatively, was seen in one patient postrectopexy (4%). The rectal axis became more vertical at rest (mean 44° *vs* 34°, $p < 0.001$) and on evacuation (mean 37° *vs* 29°, $p = 0.007$). The mean PFD decreased (4.8 cm *vs* 2.7 cm, $p < 0.0001$). The symptoms were improved in seven patients, 16 were not improved (mean follow-up 22 months). Pre-

operative evacuation time was increased in patients with poor outcome (mean 22 s (SD 12.6, range 8–60) *vs* mean 10 s (SD 3.3, range 5–15), $p = 0.009$). Rectopexy successfully prevents intussusception and significantly alters rectal configuration. Prolonged preoperative evacuation time may predict poor symptomatic outcome.

2.35 – 2.43 pm

Anal ultrasound: a useful method of assessing post-haemorrhoidectomy sphincter damage [Paper]

F G Balen, P Loder, M A Kamm and C I Bartram
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Faecal incontinence is a recognized complication of operative haemorrhoidectomy. Anal ultrasound is an established method of depicting anal sphincter anatomy and may be used to identify postoperative sphincter damage. Twenty patients who identified haemorrhoidectomy as an initiating factor for their faecal incontinence were examined with a 7 MHz rotating endoprobe. The ultrasound findings were compared with those of anal manometry and electromyography mapping. 16 (80%) of the patients studied had sphincter abnormalities identified by anal ultrasound: eight had discrete defects of the internal anal sphincter (IAS), two of whom had had previous lateral anal sphincterotomies, five patients had multiple defects of the IAS and/or external sphincter and three had fragmentation of the IAS, which is classically seen after anal stretch procedures. Four patients had normal anal endosonography—three were subsequently found to have abnormal anal sensation. These results demonstrate that sphincter damage after haemorrhoidectomy can be precisely defined using anal endosonography, which provided information comparable or additional to electromyography in most cases. In patients without ultrasonically identifiable sphincter defects, however, reduced anal sensation may contribute to faecal incontinence.

2.43 – 2.51 pm

Paradoxical contraction of the puborectalis defaecography evaluation [Paper]

D J Saranović, Z Krivokapić, N Ilić and M Kašiković
Department of Radiology, Institute of Digestive Diseases, University Clinical Centre, Belgrade 11000, Serbia

We studied the influence of the anorectal angle (ARA) on rectal evacuation in constipated patients, caused by paradoxical contraction of the puborectalis (PCPR). In 21 constipated patients and normal colonic transit time, diagnosis of rectal constipation caused by PCPR is established by defaecography (17 women, four men, mean age 42 years, range 28 63). All of them were incapable of spontaneous rectal evacuation. The mean values of ARA were 90° at rest, 79° in squeezing and 91° in straining before surgery. On the ninth day after surgery and after resection of the puborectalis in all patients control defaecography was done. The mean values of ARA were 91° at rest, 88° in squeezing and 131° in straining. Spontaneous evacuation of more than 75% of injected contrast medium was confirmed by post-surgical defaecography in 17 patients. Two patients were capable of spontaneous evacuation of less than 25% of the injected contrast medium but one was incapable even after surgery. The determination of the degree of spontaneous evacuation strongly depends on the value of the ARA in straining in patients with PCPR. Videofluoro-defaecography might give superior diagnostic evidence of PCPR in straining (when it should be relaxed), non-increased ARA, non-opening of anorectal junction and incapacity for spontaneous rectal evacuation.

2.51 – 2.55 pm

Role of fluoroscopy in enhancement of patient nutrition in a cardiac intensive care unit [Poster]

R J Chambers, S Hatfield and C Harkness
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Enhanced and continuous enteric nutrition has been shown to radically reduce the length of stay, and therefore the cost, of high-risk patients in the intensive care setting. A computerized Nutrition Flow Sheet was piloted in the Cardiac Surgery Intensive Care Unit, with four patients, demonstrating that between 84% and 98% of required nutritional needs could be achieved. Pivotal to this success is the placement of naso-enteric feeding tubes under fluoroscopic control at the bedside in the ICU. Over an 18-month period, 175 naso-enteric tubes have been placed, with a 100% success rate. Technical problems, complications, methods of radiation protection, fluoroscopy time, and estimated radiation dose will be presented. Considerably enhanced nutrition with reduced length of stay in the ICU is directly attributable to the availability and success of enteric tube placements by the radiologist. Overall, considerable cost benefits were also demonstrated.

2.55 – 2.59 pm

The role of the CT contrast enema in chronic ambulatory peritoneal dialysis (CAPD) peritonitis [Poster]

[1]P Sanville, [2]D Goldsmith, [3]D McK Manson and [1]D F Martin
Departments of [1]Radiology, [2]Renal Medicine and [3]Surgery, Withington Hospital, Manchester M20 8LR, UK

CAPD peritonitis due to extrinsic contamination is common and usually responds to conservative treatment.

Continuing sepsis suggests an intrinsic source of infection, often sigmoid diverticulitis. Such patients will rarely recover without definitive surgery. Clinical signs are often unhelpful in this situation. We have used CT contrast enema to look for indications for surgical rather than conservative treatment, in eight patients with resistant CAPD peritonitis: 500 ml of 2% Gastrografin were introduced rectally under hydrostatic pressure immediately prior to abdominal scanning. Six patients had sigmoid diverticulosis, and two had diverticular abscesses drained at laparotomy: in both there was a local area of bowel wall thickening and stricture. Two patients had negative laparotomies: one had diverticulosis but neither had evidence of bowel wall thickening. The other four settled under conservative management. Two had diffuse distal colonic wall thickening but no stricture; one had diverticulosis. Two patients had diverticulosis only. The CT enema is a useful investigation in resistant CAPD peritonitis and provides good opacification of the distal half of the colon, allowing assessment of bowel wall and lumen. Localized thickening and stricture indicate the need for surgical intervention.

2.59 – 3.03 pm
Preduodenal portal vein and associated anomalies—CT appearances [Poster]
G Walsh and M P Williams
X-ray Department, Derriford Hospital, Plymouth PL6 8DH, UK

Preduodenal portal vein (PPV) results from persistence of the ventral vitelline venous anastomosis. It was first described by Knight in 1921. PPV is a rare anomaly, 63 cases having been described in the world literature to date. Its presence in association with polysplenia is even more uncommon. Most cases of PPV have been described in children who presented with associated small bowel obstruction. We wish to illustrate the CT appearances of this very rare anomaly. *Case 1:* a 36-year-old woman with a history of multiple episodes of biochemically proven acute pancreatitis who presented for CT of abdomen, which revealed a PPV, bisplenia, a vertically orientated pancreas and midgut malrotation. *Case 2:* a 65-year-old woman with bronchial neoplasia who was referred for tumour staging: CT of the abdomen demonstrated hepatic metastases, and in addition, the presence of a PPV which continued inferiorly as a dilated superior mesenteric vein was noted. In this case, no other anomalies were evident. PPV is a rare anomaly which may be an incidental finding in adults. Its presence is important to recognize, especially in preoperative imaging, as, if undetected, it represents a significant surgical hazard.

3.03 – 3.11 pm
The angiographic appearances of portal colopathy [Paper]
H Jongschaap, J D G Rose, M Hudson and M K Bennett
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Vascular abnormalities in the gastrointestinal tract are a well-known consequence of portal hypertension. Although oesophageal and colorectal varices and large haemorrhoids are the changes most commonly described, vascular ectasia and angioma-type lesions are recognized with increasing frequency as important causes of acute and chronic GI-tract haemorrhage. We describe the angiographic appearances of colonic vascular ectasia (portal colopathy) in two patients. Both had portal hypertension secondary to end-stage cirrhosis and had episodes of GI-tract haemorrhage. The large bowel was investigated with sigmoidoscopy, rectal biopsy and mesenteric angiography. The endoscopy showed evidence of portal colopathy and this was confirmed on histology. The angiographic appearances resembled a very extensive angiomatous lesion with diffuse hypervascular mucosal staining. However, there was no significant venous shunt or enlarged veins. After the portal pressure had been reduced by a transjugular intrahepatic portosystemic shunt (TIPSS) procedure, the angiographic, endoscopic and histological appearances returned to normal. To our knowledge this is the first report of the angiographic appearances of portal colopathy.

3.11 – 3.15 pm
The elephant's trunk sign: a new sign of intussusception of tumours of the duodenal papilla [Poster]
H L Hale, S Vinnicombe and A Grundy
Department of Diagnostic Radiology, St George's Hospital, Tooting, London SW17 0QT, UK

Two cases of obstructive jaundice due to intussuscepting duodenal papillary tumours demonstrating identical cholangiographic appearances have been encountered. We propose the term "the elephant's trunk sign" as the typical cholangiographic sign of this condition. A man aged 53 years and a woman aged 83 years presented with obstructive jaundice. Percutaneous cholangiography in both demonstrated dilatation of the biliary tree, and, in particular, the distal common bile duct was seen to be swept across the mid-line before entering the duodenum. The appearances resembled an elephant's trunk. At surgery both patients were found to have large tumours arising from the duodenal papilla intussuscepted into the distal duodenum.

2.15 – 3.27 pm

Clinical Magnetic Resonance

Bramham Suite

2.15 – 2.23 pm

TurboSTIR: phantom, volunteer and patient studies [Paper]

C J Baudouin and J P Ridgway
MRI Unit, St James's University Hospital, Leeds LS9 7TF, UK

The fat suppression sequence STIR can be combined with a fast spin echo data collection (TurboSTIR), with shortening of image acquisition time. TurboSTIR was evaluated in phantom, volunteer and patient studies. Optimum TI for suppression of signal from cooking oil and a short-T_1 gel phantom was determined for conventional STIR and TurboSTIR at 1.0 Tesla. Similar optimization was performed *in vivo*. Magnetization transfer effects were assessed *in vivo* for STIR and TurboSTIR by measuring the reduction in muscle signal on single, three and nine slice data sets. STIR and TurboSTIR were compared in six patients with musculoskeletal lesions to assess fat suppression and lesion conspicuity. Optimum inversion time to null cooking oil and short-T_1 gel was approximately 25 ms shorter in TurboSTIR than STIR. A similar effect was seen *in vivo*: optimum TI STIR ms, TurboSTIR ms. Normal muscle signal decreased by 29% compared with a single slice when nine slices were obtained with TurboSTIR (14% reduction using STIR). No significant change was seen in fat or external water reference. Patient studies using TurboSTIR showed equivalent fat suppression to STIR and equal or improved lesion conspicuity. Optimum inversion time is shorter for TurboSTIR than STIR. Considerable magnetization transfer effects are present in TurboSTIR. The resulting reduction in normal muscle signal may highlight musculoskeletal abnormalities.

2.23 – 2.27 pm

Day case paediatric anaesthesia for magnetic resonance imaging [Poster]

Y Watson, D Lord, C E Hutchinson and J M Hawnaur
Department of Diagnostic Radiology, University of Manchester, Manchester M13 9PT, UK

It is usually necessary to anaesthetize or heavily sedate children aged between 9 months and 5 years for magnetic resonance imaging (MRI). Since 1991, this department has scanned over 80 children on a 0.5 T GE Vectra system using a technique of light, rapidly reversible general anaesthesia (GA). This presentation describes the technique developed by an experienced paediatric anaesthetist to allow effective day case MRI using low cost monitoring equipment. Children are brought starved to the department with an early appointment time. Full explanation of the procedure is given to the child and guardians. Emla cream is applied to the injection sites, and the child and accompanying adults escorted to the MR suite. The parents remain with the child until sedation is achieved, using intravenous Diprevan, titrated to obtain light GA. Oxygen is delivered via laryngeal mask and a pulse oximeter is set up. Using T_1 weighted spin echo sequences and T_2 weighted fast SE sequences, scan times are kept to about 5 min per sequence. The MR examination is supervised by an experienced radiologist to keep overall scan time to a minimum. Sedation is topped up with small aliquots of Diprevan between scans so that at completion of the investigation, recovery is almost immediate. The child is returned to the parents and once they have eaten or drunk, they are allowed home. High quality imaging is obtained using this technique, improving patient throughput and achieving a more efficient and economic service than other forms of sedation. A small proportion of patients (less than 5%) have to be rebooked on arrival because of inadequate starvation or respiratory tract infection.

2.27 – 2.31 pm

The place of magnetic resonance imaging (MRI) in a UK paediatric surgical centre [Poster]

T M Tsang, N Moore, N E Dudley and P K H Tam
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Magnetic resonance imaging (MRI) provides excellent multiplanar imaging without ionizing radiation but experience of its use on paediatric surgical patients in the UK remains limited. To justify its introduction in the present economic climate of the NHS, data concerning its impact on clinical management and cost-effectiveness are required. Within 18 months of the commencement of an on-site MRI service, 27 examinations were performed on 26 patients

(median age = 2.8 years, range 2 days 16 years) with the following conditions: anorectal anomaly (9), cloaca (1), neurogenic bladder (3), faecal incontinence (1), lymphangioma/haemangioma (6), skin-covered myelomeningocele (1), mediastinal parathyroid adenoma (1) and impalpable testes (4). Two examinations failed because of technical difficulties. Of infants under 1 year (n = 8), one had general anaesthesia (GA); of children between 1 and 4 years (n = 8), four had GA; no children over 4 required GA. The estimated cost of each examination was £200± (£80 for anaesthetic and £60 for day admission). The imaging was decisive in the management of eight (32%) and helpful in 14 (56%) patients. However, inconclusive or wrong information was noted in three (12%) patients. Our results suggest that MRI has a useful role in a UK paediatric surgical centre and can be cost-effective at the price quoted for "purchasers".

2.31 – 2.39 pm

Dynamic contrast-enhanced MR imaging of the liver—comparison with T_2 weighted spin-echo sequence [Paper]

J Ward, C Baudouin and P J Robinson
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The purpose of this study was to compare dynamic contrast-enhanced TurboFLASH (CETF) images with T_2 weighted spin-echo (T2WSE) images in 25 patients with focal liver lesions. MR studies used axial T2WSE (TR 2000, TE 90) imaging and axial TurboFLASH (TR 135, TE 4, FA 80°) imaging immediately following bolus injection of Gd-DTPA (0.1 mmol kg^{-1}). Fifteen 8 mm slices at 12 mm intervals were acquired in a single breath-hold period of 19 s. Each sequence was compared and scored for lesion conspicuity, level of artefact and subjective image quality. Contrast-to-noise ratio measurements are being made. 98 lesions were detected in 25 patients. CETF images detected 97 of the lesions (one was excluded from the acquisition slab) whereas only 70 were detected on T2WSE images. Five lesions were better defined by T2WSE images, 35 better defined by CETF and 30 lesions were shown equally well by both. Image quality was considered superior on T2WSE images in 4%, on CETF images in 50% and equal in 46%. Three patients had perfusion abnormalities associated with portal vein thrombosis which was better shown after contrast. Dynamic CETF imaging provides a significant improvement in lesion detection over T2WSE imaging. CETF images produce additional features which help in lesion characterization and are superior to T2WSE in assessing vascular anatomy and patency.

2.39 – 2.47 pm

Comparison of turbo and conventional T_2 weighted spin echo sequences in the detection of focal liver lesions [Paper]

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Turbo or fast T_2 weighted spin echo sequences (TSE) offer considerable time saving over conventional T_2 weighted sequences (CSE). There is debate over the role of TSE in liver imaging, particularly in the detection of focal liver lesions. This study compares CSE with TSE of two different resolutions in the detection of focal hepatic lesions. 23 patients were imaged at 1.0 Tesla. CSE (TR 2000 ms, TE 90 ms, matrix 192 × 256, two acquisitions) was compared with TSE (TR 3200–4800 ms, TE 90 ms, two acquisitions) with matrix size 192 × 256 (TSE1, 15 patients) or 256 × 256 (TSE2, eight patients). Images were qualitatively assessed by two radiologists and contrast-to-noise measurements (CNR) made. 29 focal lesions (23 malignant, six benign) were detected in 15 patients. CSE detected 97%, TSE 93%. TSE1 and TSE2 each missed one metastasis in separate patients. CSE missed 1/9 lesions in a multifocal hepatoma. TSE failed to detect ascites in one patient. Compared to TSE, artefact level was equal or lower in CSE in 97%, and overall image quality equal or higher in 95%. For all lesions measured, lesion-to-liver CNR was higher on CSE than on TSE1 and equal to or higher than on TSE2. In this study CSE detected more focal liver lesions with higher lesion-to-liver CNR than TSE at the same or increased matrix size. Caution should be exercised before replacing CSE with TSE in liver imaging.

2.47 –2.55 pm

Comparison of dynamic contrast-enhanced MRI and CT in patients with severe acute pancreatitis [Paper]

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We wished to assess the potential of dynamic contrast-enhanced MRI as an alternative to dynamic contrast-enhanced CT in patients with severe acute pancreatitis. 32 patients were imaged by dynamic contrast-enhanced CT and MR using an axial T_2 weighted spin-echo (T2WSE) sequence (TR 100, TE 4, FA 80°). 11 or 15 (rectangular field of view) alternate 5 mm slices were acquired in a single breath-hold period of 19 s before and immediately following bolus injection of Gd-DTPA (0.1 mmol kg^{-1}). 29 patients also had dynamic contrast-enhanced TurboFLASH (DCETF) images in the coronal plane. CT and MR were compared and scored for pancreatic viability and

the content of fluid collections. The location and extent of collections were noted and the presence of gas, calcification, haemorrhage, aetiology and vascular occlusion were documented. Contrast-enhanced MRI was as good as CT in distinguishing viable pancreatic tissue from areas of necrosis, and superior to CT in discriminating between fluid and solid constituents of collections. MR was significantly better than CT in demonstrating gallstones. We conclude that MR provides an alternative to CT in the management of patients with severe acute pancreatitis.

2.55 – 3.03 pm

Citrate distribution with the normal prostate gland [Paper]

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This study attempts to identify regional differences in citrate production in the normal prostate *in vivo* by proton magnetic resonance (MR) spectroscopy. Interpretation of similar data from TURP specimens is thought to be misleading due to the combined metabolic activity of stromal tissue and secretory and non-secretory epithelium from normal, neoplastic and BPH tissue. Although some *in vitro* studies have shown elevation of citrate levels in BPH and reduced or absent levels in adenocarcinoma, other studies have shown significant overlap between pathologies. Five volunteers with no previous history of genitourinary disease were studied using a GE 1.5T Signa Advantage with a pelvic phased array coil for signal reception. T2W-FSE (TR/TE = 3200/160 ms) images were used for localization of voxels (3.5 cm^3) within the central gland and peripheral zones respectively. Spectroscopic localization was carried out using STEAM (TR/TE = 1000/50 ms; 512 averages) and citrate concentrations were calculated assuming T_1 and T_2 values for citrate of 1.5 and 0.25 s respectively and a tissue water content of 44 mmol g^{-1} fresh weight. Although there was a wide variation of citrate concentrations between individuals, the peripheral zone consistently demonstrated a greater citrate concentration with a mean value ($\pm$ SD) of 117 $\pm$ 66 μmol g^{-1} compared with 60 $\pm$ 35 μmol g^{-1} for the central gland ($p < 0.05$). An intra-individual variation between the anterior and posterior aspect of the peripheral zone was also noted in all volunteers. *In vivo* proton MR spectroscopy demonstrates a difference in citrate concentration within the normal prostate between the central gland and peripheral zones. This systematic difference would suggest that *in vitro* analysis of TURP chippings may be misleading and that citrate concentrations should be mapped *in vivo* using either 2D or 3D chemical shift imaging (CSI).

3.03 – 3.11 pm

Contrast modification of 3D prostate scans by the introduction of magnetization transfer contrast [Paper]

C E Hutchinson, X P Zhu and J M Hawnaur
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In 14 male patients (average age 66.7, range 59–73 years) with carcinoma of the prostate, T_2* 3D gradient echo (GRE) sequence has been used to obtain a volume of data to plan the patients' radiotherapy. The T_2* 3D-GRE (TR 80 ms, TE 25 ms, flip angle 30°) has an intrinsically poor contrast between fat/prostate and muscle, making segmentation of the data more difficult, particularly in the important perirectal region. It is possible to increase the tissue contrast between fat, prostate and muscle by the addition of a $1\bar{2}1$ binomial magnetization transfer contrast (MTC) prepulse to the T_2*-GRE used. The optimization of this sequence allows us to obtain a good MTC effect while minimizing the energy deposition within the patient. All patients were studied using both the T_2* 3D-GRE and the MTC 3D-GRE. An improvement in the contrast of between 30–40% is seen in all patients. In nine patients the perirectal region is more clearly defined, in five the anterior (prostate–fat) margin is more clearly defined and in eight patients the zonal anatomy of the prostate is more clearly seen. Although the change in perceived outline was small, it will allow greater confidence when prescribing the radiotherapy field.

3.11 – 3.15 pm

MRI of episcleritis [Poster]

[1]J Kabala, [1]P Goddard, [2]R Harrad, [2]M Potts and [1]R Laitt
Departments of [1]Clinical Radiology and [2]Ophthalmology, United Bristol Healthcare Trust, Bristol, UK

Episcleritis is an interesting condition, presenting with signs of orbital inflammation and often proptosis. The differential diagnosis may include orbital cellulitis, abscess, tumour and pseudotumour, and ethmoid mucocele. Imaging has traditionally only offered a diagnosis by excluding other conditions. MRI of the orbits was performed on three patients with acute unilateral orbital inflammation. Turbo-spin echo sequences were obtained on a 1 T Siemens Magnetom Impact as follows: transverse multi-echo (TR 5000 ms, TE 20 and 90 ms), coronal turbo-STIR (TR 4900 ms, T_1 100 ms, TE 60 ms) and T_1 weighted (T1W), (TR 500 ms, TE 15 ms) followed by transverse and coronal T1W scans after administering gadolinium contrast agent. All patients showed thickening of the sclera/choroid which demonstrated significant enhancement following gadolinium. Two patients showed extensive infiltration of the orbital fat, with high signal material on the STIR sequence

and intermediate signal material on the T1W sequence. One patient was followed up with sequential scans which showed gradual resolution of the changes. The MRI signs offered positive support to the tentative clinical diagnosis of episcleritis, excluded significant alternative pathologies and allowed the confident diagnosis of episcleritis.

3.15 – 3.23 pm

Detection of CSF fistulae: computed tomography (CT) versus Magnetic Resonance Imaging (MRI) [Paper]

D B Stafford Johnson, A J O'Dwyer and J Toland

Department of Neuroradiology, Beaumont Hospital, Dublin 9, Ireland

Patients with cerebrospinal fistulae (CSF) often present clinicians with a diagnostic dilemma. Careful pre-operative anatomical localization of the fistula should be undertaken prior to surgical repair. The aim of this study was to compare computed tomography (CT) and magnetic resonance imaging (MRI) in the localization of CSF fistulae. Between January 1991 and December 1992, 21 patients with CSF fistulae were studied (16 males, five females, mean age 26.5 years). Their presenting complaints were rhinorrhoea (66%), recurrent meningitis (22%) and otorrhoea (12%). 14/21 patients had a history of head injury. Each patient had pre-operative CT and MR examinations and all underwent surgery. The surgical findings were used as reference for the exact anatomical site of the fistula. MRI detected CSF fistula in 16/21 patients, CT in 7/21. According to the site of the fistula, MR detected more leaks than CT: in the cribriform plate 11/14 *vs* 5/14, in the frontal bone 2/2 *vs* 1/2 and in the petrous bone 2/4 *vs* 0/4. One patient had a lesion of the sphenoid bone that was detected by both MR and CT. These results show that MR is superior to CT in the detection and localization of CSF leaks and should be the investigation of choice in patients with suspected CSF fistulae.

3.23 –3.27 pm

Magnetic Resonance Imaging of the anterior neck and floor of the mouth [Poster]

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Magnetic Resonance (MR) is potentially the optimal technique for imaging anterior neck structures (larynx and pharynx) and the floor of the mouth. Advantages over computed tomography include imaging in three orthogonal planes, no streak artefacts from dental fillings and use of non-ionizing radiation. To achieve optimum spatial resolution using thin slices, a large matrix and small field of view, the signal-to-noise ratio (SNR) must be as great as possible. The choice of receiver coil is therefore significant. This study is a comparison of the quadrature neck coil and volume neck coil used with a 0.5 T GE Vectra MR scanner. 10 patients and 10 volunteers were scanned on both surface coils. A midline sagittal localizer was performed to assess the maximum craniocaudal range of each coil and to select levels for axial imaging from C3 to C6. A T_1 weighted spin echo sequence was used, keeping image parameters the same for each receiver coil. Measurements of signal intensity were made from muscle, fat and background (noise) from both the anterior and posterior neck using the ROI facility on the imaging console. SNR was compared for each tissue type, area and surface coil. The build and posture of all patients and volunteers scanned were also recorded. The volume neck coil achieved greater SNR from the anterior structures of the neck than the quadrature neck coil. However, measurements showed that the quadrature cervical spine coil gave the best SNR for the posterior structures, including the spinal column and contents (examples will be shown). Selection of the coil giving maximum SNR enables high quality images to be obtained, but choice may be influenced by the patient habitus.

2.15 – 3.37 pm

AIDS: Radiotherapy & Radiology

Charter Suite

2.15 – 2.40 pm
The management of AIDS related malignancies [Invited Review]
M F Spittle
Consultant Clinical Oncologist, The Meyerstein Institute of Oncology, The Middlesex Hospital, Mortimer Street, London W1M 7PG, UK

Since the advent of the AIDS epidemic it has become clear that Kaposi's sarcoma and an aggressive non-Hodgkin's lymphoma occur more frequently in patients who are HIV positive. Kaposi's sarcoma has previously been seen in elderly European Jews, in patients who are iatrogenically immuno-suppressed and in the context of pre-AIDS Africa. However, the numbers seen in the West of these more traditional forms have now been superseded by Kaposi's sarcoma in AIDS patients. It is now seen in patients where the HIV infection has been contracted in Africa, but initially occurred almost entirely in the male homosexual risk group. Management of Kaposi's sarcoma by radiotherapy, immunotherapy and chemotherapy is complicated by the overwhelming importance of the immuno-suppression. Kaposi's sarcoma is becoming an increasing cause of death in AIDS patients as the infections are being prevented, recognized earlier and better treated. An aggressive non-Hodgkin's lymphoma, most frequently with extensive involvement and with B symptoms is seen in 3% of patients with AIDS. It occurs in all risk groups and the prognosis is sufficiently poor that half of the patients who contract non-Hodgkin's lymphoma will die of it. Patients must be managed according to their prognosis from the HIV infection and a poor risk group—those with a CD4 count under 100, those who have other AIDS defining diagnosis and those with a poor performance status—respond very badly to traditional chemotherapy. Patients with no poor risk factors may be treated with conventional chemotherapy and obtain lasting control. Cerebral lymphoma and carcinoma of the cervix are now AIDS defining diagnoses. Hodgkin's disease, which is frequently seen in the context of AIDS in Europe, is not as yet an AIDS defining illness.

2.40 – 3.05 pm
Imaging of malignant disease in HIV infection [Invited Review]
M A Hall-Craggs and W R Lees
Department of Radiology, The Middlesex Hospital, W1N 8AA, UK

Lymphoma in AIDS is predominantly of non-Hodgkin (NHL) type and characteristically arises in extranodal locations (60%) with the mouth and GI tract being the most common sites. NHL in AIDS is aggressive, shows an early trend to spread, frequently relapses after a good response to chemotherapy and carries a poor prognosis. Differential diagnosis is from other primary malignancy, Kaposi's sarcoma and inflammatory conditions, particularly TB in nodes and gut and CMV in the biliary tract. Focal pulmonary lesions present similar diagnostic difficulties, with infections such as *candida albicans*, pneumocystic *carinii*, TB, *aspergillus*, *bacteroides* and *staphylococcus*, all producing solitary or multiple masses. Diagnosis is by biopsy in all cases. 18 swg Trucut biopsy is safe and effective although many AIDS patients have significant coagulopathies. The neurological complications of AIDS include opportunistic infection, tumour, neuronal loss and HIV encephalopathy. The only common malignancy occurring in the central nervous system in AIDS is primary cerebral lymphoma. This does not have unique features on imaging and there is considerable overlap with toxoplasmosis; consequently diagnosis is usually delayed. The role of MR spectroscopy and radionuclide thallium scanning are currently being investigated and show promise. Metastases occur infrequently and metastases from Kaposi's sarcoma are very rare.

3.05 – 3.13 pm
Palliative radiotherapy for HIV related Kaposi's sarcoma [Paper]
[1]M Harrison, [2]K Harrington, [3]D Tomlinson and [1]S Stewart
[1]Departments of Oncology, St Mary's Hospital, Praed Street, London W2 1NY, [2]Hammersmith Hospital, Du Cane Road, London W12 0HS and [3]Department of Infectious Diseases & Genitourinary Medicine, St Mary's Hospital, Praed Street, London W2 1NY, UK

We have carried out a prospective study of radiotherapy for cosmetic efficacy in Kaposi's sarcoma. 452 KS lesions in 39 patients received superficial radiotherapy for cosmetic reasons, 311 lesions received 8 Gy in 1 fraction and 141 lesions 16 Gy in 4 fractions. 146 lesions in 21 patients were prospectively randomized to receive either 16 Gy (76 lesions) or 8 Gy (70 lesions). Responses were classified as "Complete Response", "Pigmented CR", "Partial Response" and "No Response". The post-radiation skin pigmentation was graded as 0 (none), 1 (slight), 2 (obvious) and 3 (severe). There was no significant difference in either the response rates or cosmesis between the 8 and 16 Gy regimes: CR, 59% *vs* 55%; PigCR, 16% *vs* 26%; PR, 13% *vs* 13.5% and NR, 11.5% *vs* 5.5%. Facial KS responded more favourably: CR, 82%; PigCR, 15%; PR, 1.5% and NR, 1.5%. The radiation stigmata of the 8 and 16 Gy regimes were Grade 0, 50% *vs* 56%; Grade 1, 36% *vs* 25%; Grade 2, 8% *vs* 13% and Grade 3, 0% *vs* 1%. The cosmetic results for facial lesions were Grade 0, 85% and Grade 1, 15%. Similar results were seen in the subgroup of patients whose lesions were randomized to receive each fractionation regime. We concluded that a single 8 Gy fraction offers effective palliation for HIV related Kaposi's sarcoma.

3.13 – 3.21 pm
Lung cancer in patients infected with the human immunodeficiency virus [Paper]
A R Padhani and J K Kulhman
Russell H Morgan Department of Radiology & Radiological Science, The Johns Hopkins Medical Institutions, Baltimore, MD, 21287, USA

We aimed to evaluate the patient characteristics, risk factors, and radiological appearances of lung cancer in patients infected with HIV. We present eight new patients and give a critical review of 32 previously reported cases of lung cancer in HIV-positive patients. Excluding three older patients infected by blood transfusions, the clinical profile of the remaining 37 shows a preponderance of males (32), a young age (mean 38 years, range 33–48 years), a history of smoking (34) and of intravenous drug abuse (30). Adenocarcinomas were the most common tumours (24 patients) and advanced clinical stage (3 or 4) at presentation was found in 27 patients with non-small-cell lung cancer. The radiographic appearances did not differ from the classic manifestations of lung cancer. We concluded that lung cancer in patients infected with the human immunodeficiency virus is uncommon. The clinical profile is characterized by young male patients with a history of smoking and intravenous drug abuse and advanced clinical stage at presentation. A possible increased risk of lung cancer in HIV disease has yet to be established.

3.21 – 3.29 pm
Gallium-67 citrate imaging in human immunodeficiency virus infected patients with mycobacterial disease [Paper]
J R Buscombe, P Buttery, R F Miller and P J Ell
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Mycobacterial disease is becoming more common in the United Kingdom, particularly in patients infected with the Human Immunodeficiency Virus (HIV). Rapid diagnosis is required for the patient's survival. The diagnosis, especially of the atypical form of the disease, can be difficult, with microbiological cultures taking up to 6 weeks to grow. Scintigraphy with ^{67}Ga citrate may be useful in identifying the presence of disease. The aim of the study was to determine if any clear pattern of abnormal ^{67}Ga citrate accumulation was seen in mycobacterial disease in HIV infected patients which could be used for diagnosis. We retrospectively reviewed 21 ^{67}Ga citrate studies on 21 HIV infected patients (19M, 2F, mean age 33) after mycobacterial disease had been confirmed. Lung uptake was seen in 10 patients (48%, lymph node uptake in 11 (52%), sinus uptake in 14 (67%), colonic uptake in 15 (70%), lacrimal uptake in nine (43%) and parotid uptake in four (19%). Reduced or absent bone marrow uptake was seen in 13 (62%) cases. In conclusion, a wide range of abnormalities can be seen on ^{67}Ga citrate scintigraphy in mycobacterial disease in HIV infected patients. However, no clear diagnostic pattern of activities can be seen.

3.29 – 3.37 pm

Proton MR spectroscopy in AIDS: multi-centre trial on mode of transmission [Paper]

[1]M Paley, [2]J Alonso, [3]P Cozzone, [4]R Sauter, [1]I D Wilkinson, [1]W K Chong, [1]R J S Chinn, [1]J K Shepherd, [1]B E Kendall, [1]M A Hall-Craggs, [1]M J G Harrison and others

Magnetic Resonance Imaging Departments, [1]Middlesex Hospital, London W1N 8AA, UK; [2]Vall d'Hebron, Barcelona, Spain; [3]CRMBM, Marseille, France; [4]Siemens AG, Erlangen, Germany

Human immunodeficiency virus (HIV) infection may be transmitted through male homosexual practices or intravenous drug use. The aim of this study was to compare the proton metabolite ratios in patients infected through these two routes. Proton spectra have been acquired from the brains of 138 HIV-1 infected patients and 55 HIV seronegative controls as part of a multi-centre study. Data was acquired at three sites in London, Barcelona and Marseille. The London group of patients consisted exclusively of male homosexuals while the Barcelona and Marseille patients were predominantly intravenous drug users. Single 8 ml voxels located in parieto-occipital white matter were acquired with TR/TE = 1600/135 ms, 256 acquisitions. There was no significant difference in mean age, CD4 count or NA/Cr ratios between the male homosexuals (n = 59, Na/Cr = 1.82 $\pm$ 0.36) and the male intravenous drug-using AIDS patients (n = 26, NA/Cr = 1.88 $\pm$ 0.51). Both groups had significantly different NA/Cr ratios (ANOVA with Scheffe F-test at 95%) from the control group (n = 55, NA/Cr = 2.28 $\pm$ 0.33) This suggests that mode of transmission of HIV infection is not significant in the changes observed in the proton spectra of AIDS patients.

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