Scientific Programme Abstracts

Monday 11 June

Harewood Suite

Central Nervous System (9.00–10.15)

MRI disorders of the spinal column; pathophysiological insights and contribution to management

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The development of surface coil imaging of the spinal column which permits high-quality thin-section studies without planar restriction has led to MRI becoming the preferred method of addressing many types of clinical problems, especially those based on disc pathology. It has become apparent that MRI is a valuable research tool for studying fundamental questions relating to the pathophysiology and natural history of several conditions involving the spinal column. The pathophysiology of disc degeneration, which is part of normal senescence, is complex and incompletely understood. It is associated with reduction in signal from the central portion of the disc on T_2-weighted images which correlates closely with discographic evidence of disc degeneration. The high incidence of premature disc degeneration in adolescents with disc protrusion suggests a possible underlying diathesis in some individuals. The increased prevalence of disc degeneration in the disc below a neural arch defect in spondylolysis suggests that disc failure is potentiated by mechanical stress. In Scheuermann's kyphosis also, loss of nuclear signal at multiple levels is probably secondary to repetitive microtrauma to the discovertebral junction. Studies in an animal model have demonstrated the evolution of changes which occur in disc space infection and emphasize the value of the technique in early diagnosis and the recognition of extension into the extradural space.

Magnetic resonance imaging of vascular abnormalities of the CNS

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Magnetic Resonance (MR) findings in vascular malformations and aneurysms of the brain and spine are reviewed with particular reference to the role of gadolinium-DTPA (Gd-DTPA).Thirty-five patients (F=21, M=14, age 27–75 years) were scanned on a 0.26T superconducting magnet system. Spin echo and partial saturation recovery sequences (SE560–2000/26-120; PSR500/18) were obtained in various planes using head or spine surface coils. In 24 patients, T_1-weighted sequences were repeated after Gd-DTPA. Eighteen patients had a intracranial arteriovenous malformation (AVM) and 10 had spinal AVMs. On MR, patent vessels showed signal void, and haemorrhage and infarction were identified but calcification was not always apparent. Increased signal intensity was observed within some AVMs after Gd-DTPA but generally enhancement was minimal. Spinal dural AVMs were associated with cord expansion, abnormal signal intensity and diffuse enhancement following Gd-DTPA, more intense on delayed scans. Patients with intramedullary AVMs tended to present acutely with signs of haemorrhage on MR and no enhancement after Gd-DTPA. Seven patients with aneurysms were studied, six with giant cerebral aneurysms (GCA). MR findings included signal void in the patent lumen, with surrounding laminated thrombus, evidence of haemorrhage and peri-aneurysmal oedema. Slight peri-aneurysmal parenchymal enhancement occurred in patients given Gd-DTPA. Vascular malformations have a specific appearance on MR which can also demonstrate their effect on brain or spine. The use of Gd-DTPA does not increase the diagnostic information obtained.

Craniospinal magnetic resonance imaging in neurofibromatosis

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The role of craniospinal Magnetic Resonance Imaging (MRI) in patients with neurofibromatosis (NF) and neurological symptoms has been reviewed. Seventeen patients (M=12, F=5; age range 9-75 years) were studied on a 0.26T superconducting magnet system using a variety of T_1- and T_2-weighted sequences (spin echo 500–2000/26–120; partial saturation recovery 500/18). In eight patients the T_1-weighted sequences were repeated following 0.1 mmol gadolinium-DTPA (Gd-DTPA) per kg body weight. Cranial imaging revealed at least two lesions in five out of nine patients studied, including two cerebellar gliomas, three areas of grey matter heterotopia, two optic gliomas, three acoustic neuromas (bilateral in one) and multiple meningiomas in two. Gd-DTPA improved identification of intrameatal acoustic neuromas, meningiomas and cerebellar gliomas. Spinal imaging in 10 patients demonstrated neurofibromas to be isointense with neural tissue on T_1-weighted sequences. All enhanced following Gd-DTPA improving conspicuity of lesions. On T_2-weighted sequences neurofibromas demonstrated high signal with a heterogenous low signal centre to most lesions greater than 3 cm diameter. Gd-DTPA improved identification of small intradural tumours. MRI demonstrated extent of craniospinal involvement in NF, frequently identifying asymptomatic tumours. Gd-DTPA improved conspicuity of small lesions. MRI may be a useful screening technique in families with central NF.

Changes in regional cerebral blood flow of patients with hydrocephalus after CSF shunting: detection by $^{99}Tc^m$-HMPAO SPECT

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Obstruction of the cerebrospinal fluid (CSF) pathways decreases regional cerebral blood flow (rCBF). It was demonstrated by experiments that shunting of CSF from ventricles increased rCBF if hydrocephalus was present for less than 8 weeks. But there was no clinical study confirming this finding. Therefore this study was designed to evaluate the effect of shunting on rCBF in patients with different durations of high-pressure hydrocephalus. Fifteen patients (eight male, seven female, age range 1 week–56 years) underwent CT and $^{99}Tc^m$-HMPAO SPECT examination before and after shunting. The patients were divided into three groups according to the post-operative scintigraphic finding (see Table). Pre- and post-operative quantitative analysis of rCBF for each lobe was done by taking the cerebellum as a reference region. A diffuse increase in rCBF, predominantly in the frontal region, was noticed post-operatively in Groups A (marked) and B (moderate) but not in Group C. It is suggested that although the dilated ventricles became smaller post-operatively regardless of the duration, no improvement in rCBF was detected if hydrocephalus was present for more than 12 weeks.

	Group A (n=6)	Group B (n=4)	Group C (n=5)
Increase in rCBF (%) (Mean of all lobes)	15.5±3.5	10.25±9.1	1.19±1.2
Mean duration of hydrocephalus (weeks)	5±0.5	8±1	≥12
Decrease in ventricle size (on CT)	+	+	+

Computerized tomography of the brain: does contrast enhancement really help?

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Established policies regarding the use of intravenous contrast in Computerised Tomography (CT) of the brain are largely based on experience with early scanners. Given the high resolution of current generation scanners, we have conducted a prospective study to reassess the contribution of intravenous contrast to the final diagnosis in cranial CT. Three hundred patients who required intravenous contrast during routine axial cranial CT were included in the study. Two hundred and twelve patients presented with symptoms or signs suggesting focal intracranial pathology and 88 with non-focal features. A total of 110 post-contrast scans were abnormal. The differential diagnosis was altered in 15 patients following contrast enhancement, 13 of whom presented with focal features. In 3 patients with normal plain scans abnormalities were only seen after contrast. In a further 15 patients contrast enhancement increased the certainty of the diagnosis made on the uncontrasted scan. Despite the improvements of current CT scanners, we feel that intravenous contrast enhancement alters the differential diagnosis and the degree of confidence in sufficient patients to justify its continued widespread use.

Computed tomography in the evaluation of idiopathic pseudotumour of the orbit

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Orbital pseudotumour is an inflammatory process for which no identifiable cause can be found. Certain features on computed tomography (CT), together with a classical clinical picture, can allow a specific diagnosis to be made. We examined 13 patients with inflammatory orbital pseudotumour using CT. The CT appearances were correlated with clinical presentation and with response to treatment. Proptosis and diplopia were found with all varieties of CT appearance. Visual loss was associated with direct involvement of the optic nerve. The Tolosa Hunt Syndrome was found with lesions related to the superior orbital fissure. Biopsy may worsen the clinical course of this disease. In several cases the typical CT appearances combined with the clinical presentation obviated the need for biopsy. CT was helpful in predicting response to treatment. Patients with lesions confined to the lacrimal gland or extraocular muscles, or those with an inflammatory mass of less than 1 cm, had a rapid and sustained response to oral steroids. Those with a larger mass, diffuse disease or involvement of the sclera had a poor response to steroid treatment and required immunosuppressants. Patients with involvement of the optic nerve suffered permanent visual loss. We present our findings in these patients with idiopathic orbital pseudotumour.

MRI and RARE myelography in diagnosis of spinal cord compression due to metastatic disease

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Fifty-two patients with known malignancies outside the central nervous system had magnetic resonance imaging (MRI) of the spine for the investigation of possible metastatic compression of the spinal cord and cauda equina. T_1-weighted sagittal sections of the spine and additionally rapid acquisition with relaxation enhancement (RARE) hydrography were performed using a whole-body MRI system operating at a field strength of 0.23 Tesla, corresponding to 10 MHz proton resonance frequency. RARE hydrography yields T_2-weighted aqueous fluid-specific images within a few seconds and offers a rapid non-tomographic approach to MR myelography. Plain radiography of the spine did not contribute to the diagnosis of tumour extension. CT proved accurate in diagnosis of osteolytic lesions, especially of the vertebral arch and articular processes. MRI results were compared with neurosurgical findings and histological examinations of the spinal or epidural lesion in 27 patients. Sensitivity of RARE myelography for metastatic compression of the spinal cord or cauda equina was 100%. RARE myelography thus provides a rapid and sensitive diagnosis of complete or partial block of the spinal canal and may substitute for myelography in the preoperative work-up.

Paranasal sinus abnormalities in patients referred for cranial CT

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Paranasal sinus (PNS) disease is an area of confusion both in ENT practice and for us as radiologists. Both clinical and radiological diagnoses are dependent on identifying maxillary or frontal disease. Recently the importance of the ethmoid sinuses in relation to the pathogenesis and treatment of maxillary and frontal sinus disease has been recognized. CT is superior to standard PNS radiography in demonstrating the ethmoid sinuses. We have performed a prospective analysis of the PNS of 235 patients with non-sinus-related problems who were referred for cranial CT, in an attempt to identify the patterns of disease in this population. This was not an asymptomatic population and patients fell into one of four groups (see Table). Of patients with CT demonstrable disease, 47% had involvement of the anterior ethmoid sinuses. The results of our study have shown that sinus occurs in 26% of patients referred for cranial CT for non-sinus-related problems, and that a clinical history of sinus disease is a poor indicator of the presence of sinus disease. The implication of these results is discussed, with particular reference to our ENT collaboration and new techniques in endoscopic surgical treatment.

Group 1	PNS symptoms/no CT-demonstrable PNS disease	78 (33.2%)
Group 2	PNS symptoms/CT-demonstrable PNS disease	43 (18.3%)
Group 3	No PNS symptoms/CT-demonstrable PNS disease	18 (7.7%)
Group 4	No PNS symptoms/no CT-demonstrable PNS disease	94 (40%)

Magnetic resonance angiography of dural sinus thrombosis

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Magnetic resonance imaging (MRI) has been recommended in the detection of dural sinus thrombosis. The presence of high signal in the sinuses, instead of the normal flow void, is a reliable indicator of thrombosis. Demonstration of flow obstruction, however, has relied upon conventional X-ray angiographic techniques. We describe MR venous angiography to augment MR assessment of dural sinus thrombosis. Cerebral venograms were produced in volunteers (six) and patients (three), using the inflow technique. This is based upon the flow-related enhancement obtained with short-TR velocity-compensated field–echo pulse sequences and provides a high contrast between moving blood and stationary tissue. A stack 50 x 2 mm slices were acquired using a 2D multislice sequence. A presaturation slab positioned proximal to the imaging region allows suppression of arterial flow. The data were reformatted and a maximum intensity ray tracing algorithm applied to produce an angiographic projection; combining projections with different viewing angles in a cine sequence provided an impression of the 3D nature of the vasculature (ANALYZE, BRU, Mayo Foundation). The flow images demonstrate the sagittal, straight and transverse sinuses in normal subjects. In patients with dural sinus thrombosis the absence of flow in the sinuses was demonstrated. In one patient, follow-up MR angiography demonstrated the gradual return of flow to the sinuses over a few weeks in response to anticoagulant therapy. Combined MR imaging and angiography enables a more complete assessment of dural sinus thrombosis. It does not require ionizing radiation, contrast media or vessel puncture and may be the imaging modality of choice for assessing this condition.

Notes

Trauma (10.45–12.00)

The radiology of chest trauma

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Experience of chest trauma in Northern Ireland is somewhat unique within the United Kingdom, owing to our continuing civil unrest. Over 300 cases of major thoracic trauma have been treated in the Regional Thoracic Surgical Unit since 1982. Many patients have multiple injuries affecting more than one system, therefore initial assessment by an experienced clinician is vital. The role of the radiologist is important but must be secondary to good clinical assessment and resuscitation. In the acute situation time often permits only limited radiography. This is usually a supine AP film which can be difficult to interpret. Variation due to technique must be recognized. Cases are discussed with special reference to assessment of the initial plain radiograph and the necessity for further radiology. Late developments and complications are addressed, as well as chest complications of trauma to other areas, such as the abdomen and cranium.

The significance of multiple posterior urethral false passages following pelvic trauma

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Ten per cent of pelvic fractures are associated with urethral trauma, which can result in complete disruption to stricturing of the posterior urethra. Pre-operative imaging provides information on the site and extent of pathology, the competence of the sphincter mechanisms and whether there are false passages. Ten cases are presented. All had urethral pathology due to trauma, and attempted primary repair of a defect or dilatation of a stricture, and were referred with supra-pubic catheters *in situ*. Pre-urethroplasty work-up included combined cystography and retrograde urethrography. In seven out of 10 patients, two bladder necks associated with false passages were identified and in the other three, multiple bladder necks. Urethral defects involving the distal sphincter mechanism were identified in five. In all patients, the true posterior urethra could be distinguished by recognition of the verumontanum and residual bladder neck sphincter activity. Before reconstructive surgery it is important to depict urethral anatomy accurately following trauma. This presentation stresses the salient points in identifying the true posterior urethra in 10 patients in whom the distal sphincter mechanism has been compromised.

MRI of acute, sub-acute and chronic spinal trauma

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MR imaging was performed in 90 patients with a history of spinal trauma; in 40, injury had occurred in the previous 6 months (acute); in the remainder from between 6 months and one year (sub-acute), and up to 40 years (chronic). In the acute group abnormalities were shown in the extraspinal soft tissues, the vertebral column including the intervertebral discs and within the spinal canal in 38%, 62% and 55% respectively. Ten cases showed abnormality in all three regions and 10 no abnormality. Many of the findings such as acute disc herniation have significant management implications. In the sub-acute and chronic groups extraspinal soft-tissue abnormalities were present in only eight cases (16%) and six of these were a result of previous surgery. The vertebral column was abnormal in 82% and the cord showed areas of abnormal signal or morphology in 50%. Of these there were 10 cases of syringohydromyelia (which was never seen within 6 months of injury): five with isolated cord compression, eight with cord atrophy and five with changes consistent with cystic myelomalacia. The underlying pathophysiology of abnormal cord morphology and signal intensity, which is seen in both the acute and chronic stages, is incompletely understood. The morphological appearance of syringohydromyelic cavities, which is usually different above and below the level of injury, is possibly related to alterations in CSF flow secondary to focal canal stenosis.

Real-time sonographic assessment of suspected scaphoid fracture

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The common clinical problem of the correct management for patients with suspected scaphoid fracture in the presence of normal carpal radiography remains unclear. The radial artery traverses the anatomical snuff-box in close proximity to the scaphoid, separated only by a thin layer of synovial fluid, synovium and wrist joint capsule/radial collateral ligament. Consequently if the scaphoid-radial artery distance is increased it must be because of a joint effusion/haemarthrosis, synovitis or capsule/collateral ligament injury. Both radial artery and carpal bone contours are clearly seen on ultrasound. We now present our preliminary findings on the use of real-time ultrasound in the assessment of suspected scaphoid fracture. An initial volunteer normal/asymptomatic control group (17 women, three men; age range 22–61 years, mean 29.0 years) was examined sonographically comparing the scaphoid-radial artery distance for both wrists. Values ranged from 2.2 to 4.0 mm (mean 2.93 mm) with a variation between limbs ranging from 0.0 to 0.8 mm (mean 0.25 mm). In our study group we examined 18 patients with clinically suspected scaphoid fractures. The nine patients with normal scans all failed to show evidence of bony injury at follow-up. In the nine patients with scaphoid-radial artery distances outside the normal range, two patients had old scaphoid fractures, one a new fracture at the scaphoid waist and one a bony avulsion of the distal pole of scaphoid-radial collateral ligament. Further studies are required to provide a conclusive statistical correlation.

Real-time digital contrast enhancement and magnification in the assessment of scaphoid and other wrist injuries

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A study was conducted on the value of a commercially available desk-top digital contrast enhancer-magnifier (DETECT system) in a series of 550 patients presenting with an acute wrist injury. Four radiologists, of varying experience, independently reviewed the radiographs on a conventional lightbox and subsequently with the "digitizer". Statistical analysis was performed on the collated observations. In the scaphoid series (350 cases) the performance of the two more experienced radiologists was marginally better with the digitizer whereas the less experienced radiologists performed slightly worse. Overall the digitizer improved the confidence of the radiologists in correctly diagnosing the presence of a scaphoid fracture but for the less experienced radiologists this was at the expense of identifying normality. In the wrist series (200 cases) the use of the digitizer resulted in a minor increase in the true positive and decrease in the false negative observations but this was offset by a concomitant minor increase in the false positive and decrease in the true negative categories. Evaluation of the soft-tissue planes around the wrist joint showed a limited value in the identification of a scaphoid fracture with an overall positive predictive value of 0.26. Correlation of soft-tissue changes and the presence or absence of a scaphoid fracture was slightly worse with the digitizer. Possible causes for the apparently poorer performance of the digitizer are discussed as well as the relative merits and potential value of the unit.

Pitfalls in bone scintigraphy for suspected hip fracture

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$^{99}Tc^{m}$-MDP bone scintigraphy has been advocated as a highly sensitive and specific method of identifying "occult" fractures of the hip in elderly patients who present with an acutely painful hip, and normal plain radiographs. Previous studies have shown bone scintigraphy to be totally reliable in the identification of these fractures, there being no false-positive or false-negative results. However, continued experience has highlighted several diagnostic difficulties and pitfalls. In a review of 2617 patients who were admitted with a suspected fractured neck of femur over a period of 5 years, 213 had no detectable fracture on plain radiographs, and were subsequently investigated by bone scintigraphy. Normal scans were obtained in 127 cases (60%). Of the remaining 86 cases, 82 (38%) were reported to show fractures of the proximal femur, three showed pubic ramus fractures, and one acetabular fracture was demonstrated. Review and follow-up have identified several false-positive and two false-negative scans. The various factors accounting for these errors are considered, and the clinical implications discussed. Bone scintigraphy remains a very useful test for detecting occult fractures of the hip and surrounding skeleton, but careful analysis should be made within the context of the clinical findings and plain radiographs in order to avoid the diagnostic pitfalls of this investigation.

Fractures of the atlas vertebra

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A total of 52 cases of atlas fractures were admitted to the Spinal Injury Unit over a 14-year period. Two groups are apparent, which differ in age, presentation, mechanism of injury, radiology and treatment given. Patients with Jefferson fractures were on average 42 years of age and the radiology, including CT, is presented. Correlation of the radiology initially, during traction and follow-up is discussed. Cases of posterior arch fractures were on average 17 years older, and had marked degenerative changes in the mid to distal cervical spine fracture. Injury in the elderly was often after minor trauma.

An assessment of triage of casualty radiographs by radiographers

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A study has been undertaken to assess the ability of radiographers in a busy accident and emergency department to triage patients on the basis of their radiographs. A total of 3000 patients have been studied. The radiographers performing the radiographs were offered a choice of four categories in their assessment: normal, abnormal, insignificantly abnormal, or further advice required. Their choice was compared with an assessment made by the radiologist reporting the film (from the categories normal, abnormal, insignificantly abnormal). The assessments were made independently. The results are presented. With ever-increasing demands on radiologists' time, these results could point a way towards reducing errors in radiographic interpretation by unsupervised junior casualty staff. An extension of the study is planned with larger patient numbers, and subsequently an assessment of formal reporting by radiographers.

Computed tomographic assessment of old calcaneal fractures

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There is limited consensus as to the most appropriate treatment for the acute calcaneal fracture, and a large proportion of patients may be left with long-term disability and pain. In this prospective study high-resolution CT in axial and coronal planes was performed in 61 patients with 71 old calcaneal fractures. The series comprised 45 men and 16 women with an age range of 12 to 83 years (mean 49.7 years). The time interval between the occurrence of the fracture and the CT examination ranged from 6 to 300 months (mean 32.2 months). The CT images on both bone and soft-tissue window settings were assessed for fracture healing, secondary degenerative changes, alterations in calcaneal configuration and abnormalities of the adjacent tendon. Of the 49 intra-articular fractures, flattening of the calcaneum was revealed in 92%, osteoarthrosis of the posterior subtalar joint in 90%, lateral spur formation in 75%, intra-articular loose bodies in 26.5% and involvement of the calcaneo-cuboid joint in 35% of cases. Peroneal tendon abnormalities were identified in 75% of cases, with subluxation or dislocation of the tendons in 49%. Medial tendon abnormality was revealed in 18.4% of cases. These findings are correlated with the patients' current clinical conditions, and the relative merits of measuring the calcaneal height, heel-valgus and sustentacular angles and medial offset of the talar head from the CT examinations are discussed.

3D-CT of pelvic fractures

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Pelvic and acetabular fractures often occur in young patients and accurate open reduction with internal fixation now offers the chance of achieving a better long-term result by reducing subsequent degenerative changes. Pre-operative planning with detailed knowledge of the three dimensional anatomy of these fractures is vital to ensure the best possible outcome. Current methods of evaluation include Judet views and axial CT scanning. The aim of this study was to assess whether 3D CT reconstruction improves pre-operative planning. Seven patients have been investigated, three transverse acetabular fractures with separation of a posterior fragment, two two-column fractures, a bilateral sacroiliac dislocation and a bilateral sacral fracture with diastasis of the pubic symphysis. Plain radiography with Judet views and axial CT scans with 3D reconstruction were performed in all cases. The scans were performed on a Somatom DR H scanner and the 3D reconstructions were made using a surface imaging technique utilizing the scanner's own computer. 3D CT reconstructions were helpful in all cases. The complex anatomy of the pelvic fractures, in particular the precise relationships of all the fragments, was clearly demonstrated. Although the three imaging techniques are complementary, 3D CT presents the information in a more readily interpretable form, facilitating pre-operative planning.

Skeletal Studies (2.30–3.45)

Current trends in the radiology of joint disease.

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Abstract not received.

Ultrasound and MRI diagnosis of meniscal cysts

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Cystic change in a degenerate meniscus occurs in 2.5% of medial and 22.2% of lateral menisci and is usually confined within the fibrocartilage. Occasionally, the cyst can enlarge and migrate and present as a mass around the knee. Recent evidence indicates that there is always an associated tear of the underlying meniscus, most often a horizontal linear or serpentine cleavage tear. The hypothesis is that synovial fluid is forced along the tear and into the cyst, causing enlargement. The diagnosis is often missed by arthrography and arthroscopy. We present three cases of meniscal cyst (two lateral and one medial) diagnosed by ultrasound and MRI. On ultrasound the cysts were generally hypoechoic but contained focal areas of highly echogenic material presumed to be debris, and also internal septa. On MRI the cysts were of low intensity, similar to that of muscle on, T_1-weighted images, and very intense on heavily T_2-weighted images, indicating a high water content. Ultrasound showed an abnormal meniscus in the two cases of lateral meniscus; and MRI demonstrated clearly the torn meniscus and its continuity with the cyst in all three cases. While it is possible to make the diagnosis using both imaging methods, MRI gave more useful and complete information than ultrasound.

Comparison of marrow and bone scintigraphy of vascular bone grafts for femoral head necrosis in 28 patients

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We compared marrow with bone scintigraphy in 28 patients with femoral head avascular necrosis due to trauma or idiopathic causes. All had vascular bone grafts. The demonstration of vascular bone graft viability in the early post-operative period is bedevilled by intense tracer uptake in surrounding bone and soft tissues. Viable bone graft contains marrow while the femoral head and non-viable graft are avascular. Scintigraphy was performed pre-operatively in the majority and post-operatively in all. Marrow scintigraphy was performed using 370 MBq (10 mCi) tin colloid. Three-phase bone scintigraphy was performed using 555 MBq (15 mCi) diphosphonate. Differentiation of viable from non-viable graft in the post-operative bone scintigram was impossible. However, marrow scintigraphy frequently showed a viable graft despite the drawbacks of marrow scintigraphy such as deficient marrow, poor tracer uptake, high blood pool activity and orthopaedic ironmongery. Marrow scintigraphy is superior to bone scintigraphy in demonstrating viability of vascular bone grafts.

Bilateral wrist arthrography in patients with unilateral symptoms

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Bilateral tricompartmental wrist arthrograms have been performed in 13 patients with unilateral symptoms to assess the incidence of abnormal findings in the symptomatic and asymptomatic wrist. The midcarpal, distal radio-ulnar and radiocarpal joints were injected separately with a mixture of ioxoglate 320 and lignocaine. Arthrography was normal in 5/13 symptomatic wrists. Abnormalities in the remaining eight included one partial and four complete tears of the triangular fibrocartilage complex (TFCC), two lunotriquetral ligament tears, two scapholunate tears and five other abnormal joint communications. One lunotriquetral ligament tear in a patient with probable inflammatory disease was not thought clinically significant. In 13 asymptomatic wrists there were 4 (31%) with abnormalities. There were two tears of the TFCC, 1 scapholunate tear, and 4 other abnormal joint communications. Absence of lignocaine-induced pain relief suggested extra-articular causes of symptoms in 3 wrists, 2 of which had arthrographic abnormalities. This study shows that triple-compartment wrist arthrography may demonstrate tears in asymptomatic wrists, and therefore care must be taken in interpreting any positive findings in a painful wrist.

Assessment of bone scintigraphy in the diagnosis of scaphoid fractures

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Plain film radiography in the diagnosis of scaphoid fractures is known to be unsatisfactory, with a significant false-negative rate, even in experienced hands. Bone scintigraphy is used for this purpose in our centre on patients in whom fracture has been assessed clinically but not demonstrated on plain radiographs either at presentation or 10 days post-trauma. We have compared results of bone scintigraphy and plain radiography in 100 such cases retrospectively. Radiographs were reported "blind" by a consultant bone radiologist (N.A.B.) as were the scintigraphic images. In 25 patients, fractures were shown on scintigraphy which were not seen on radiography. Eight patients with at least one radiograph assessed as suspicious of, but not diagnostic of, fracture had the diagnosis refuted by scintigraphy. Follow-up radiography on some patients showed that most fractures diagnosed on scintigraphy did not become visible subsequently. The results show that bone scintigraphy adds diagnostically significant information in 33% of patients studied. These results, and comparisons with previous studies, are discussed, and examples of potential pitfalls in the interpretation of scintigraphic images are shown.

Sonographic assessment of medial collateral ligament injuries to the knee

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High-resolution real-time diagnostic ultrasound has found increasing use in the evaluation of acute and chronic soft tissue injuries. Sonography is able to distinguish the deep and superficial static and dynamic medial supporting structures of the knee. We now present our findings in 17 patients with clinically suspected isolated medial stabilizer injuries (Grades I and II sprains) to the knee. In five patients there was sonographically demonstrable calcification in the region of the medial capsular attachment to the medial femoral condyle, *i.e.* Pellegrini–Steida type lesion. The high incidence of these lesions probably reflects the referral process for our study. We discuss the possible patho-physiological mechanism for such phenomena, based on our sonographic findings. We were able to localize the precise anatomical site and extent of collateral ligament ruptures and avulsions in seven cases. In the remaining five patients, ultrasound was able to diagnose a medial meniscal tear and osteoarthritic changes not fully appreciated on plain radiography and in a third patient, a loose body within the medial femoral recess previously misdiagnosed as a Pellegrini–Steida lesion on plain radiographs. The remaining two patients were sonographically normal except for mild joint effusions and may represent meniscal injuries, although the exact diagnosis is unclear. We conclude by discussing the clinical relevance of ultrasound in the management of knee injuries.

Radiological features during and following treatment of spinal tuberculosis

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Following the advent of effective chemotherapy, the incidence and morbidity of spinal tuberculosis has improved dramatically. Response is measured with a combination of clinical and radiological features. We have reviewed 28 cases of vertebral tuberculosis to document the sequence of radiological changes following treatment. Bone destruction was demonstrated in 24 cases at presentation, being delayed in the remainder for up to 3 months. Destruction progressed whilst on treatment for an average of 6.5 months, progressive vertebral collapse continued for up to 14 months. Only three patients showed evidence of vertebral height recovery. Disc height was reduced in 20. Vertebral fusion occurred in 75% of these, the onset varying between 3 weeks and 27 months. A paraspinal soft-tissue mass was present in 75% of those with cervical or thoracic disease. The mass enlarged in most cases, for up to 5 months. Complete resolution took between 3 and 24 months. Osteosclerosis was present at onset in 13 cases and developed in a further 12, always within 5 months. Maximal sclerosis occurred at up to 14 months. Bone density returned to normal in 11 cases, taking up to 59 months. It is important for the radiologist to appreciate the varied radiological response to successful treatment of spinal tuberculosis.

Symptomatic dorsal defects of the patella

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"Dorsal defect of the patella" involves the supero-lateral portion of the patella, is deemed incidental and of no clinical significance. The plain radiographic appearances are similar to the centrally located "osteochondritis dissecans" which needs further evaluation and treatment. Eighteen patients with a combination of anterior knee pain and a subarticular patellar defect have been prospectively studied utilizing plain radiography, double contrast arthrography, CT and scintigraphy. The clinical and radiological features in symptomatic dorsal defects of the patella are compared with those of osteochondritis dissecans. Double-contrast CT arthrography in 10 patients with dorsal defects of the patella revealed significant abnormalities in the overlying articular cartilage which were confirmed arthroscopically. These were scintigraphically active and associated with abnormal patellar tracking. Osteochondritis dissecans cases showed similar scintigraphic and CT arthrographic findings, with retention of the functional patello-femoral relationship. The results suggest that the dorsal defect should not be dismissed as an innocent finding in symptomatic cases, and requires further radiological investigation. The distinction drawn between the dorsal defect and osteochondritis dissecans of the patella is questioned and the aetiological role and therapeutic implications of patellar tracking abnormalities are discussed.

Is there a familial link in early disc failure?

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Adolescent disc failure, whilst rare, is frequently associated with multiple-level disc abnormalities, suggesting an underlying diathesis. The present study investigates the possibility of a familial factor in early disc failure. MR scanning of the lumbar spine was carried out in the sagittal plane on 45 first-degree relatives of 15 patients with adolescent disc herniation. An assessment was made of the signal returned from the central part of each disc on the STIR sequence and allocated a score on a scale of 0–4 (0=normal signal, 4= complete loss of signal). The results were compared with those from the same number of age- and sex-matched controls. Comparison of the two groups of scores was made using the Mann–Whitney *U* test for non-parametric data. As expected the L4-5 and S-1 discs scored the highest, these being the commonest levels to undergo degeneration. The first-degree relatives of the patients had a level of disc degeneration which was significantly greater than that of the control group; this difference was more pronounced in the caudal discs. We conclude that in some individuals the predisposition to early disc failure may have a familial component.

CT and isotope bone scan appearances of the knee joint following replacement of the anterior cruciate ligament

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This poster illustrates the appearance of the knee joint following the insertion of an open-weave polyester prosthetic ligament. The prosthesis replaces the native anterior cruciate ligament and extends from the medial tibial condyle to the lateral femoral condyle, running within a surgically constructed endosteal tunnel. The ligament is anchored at either end by a bone plug which fits inside the stocking-like ligament. The plug is, in fact, the core of bone produced by formation of the tunnel. Scans of the knee were obtained following injection of $^{99}Tc^{m}$-MDP. Five patients, all of whom had a successful surgical result, were studied post-operatively. The static isotope scan shows varying degrees of increased activity in the tibial plateau and femoral condyles. The activity mirrors the osteochondral junction around the articular margins of femur and tibia. It is not at present known what pathological process this represents. One patient had marked isotope uptake in the tibial canal. CT scanning shows marked bony bridging between the plug and canal. CT scans were obtained on all patients; they show well corticated endosteal tunnels with varying degrees of bridging between tunnel and plug.

Notes

MRI of the Knee (4.15–4.35)

MRI of the knee

C. W. Heron
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MRI is firmly established as the technique of choice of the non-invasive evaluation of disorders of the knee. In places where MRI is widely available it has replaced arthrography and reduced the indications for diagnostic arthroscopy. Imaging may be performed using conventional T_1- and T_2-weighted pulse sequences but volume gradient echo techniques reduce examination times and improve resolution. MRI enables the accurate assessment of all degrees of meniscal degeneration. An area of high signal intensity extending to an articular margin indicates a tear, whereas intrameniscal high signal indicates degenerative change. The integrity of the cruciate and collateral ligaments may be assessed using MRI. A tear is diagnosed when there is failure to visualize the ligament on thin contiguous sections, or an area of high signal intensity fluid crosses the ligament on T_2-weighted images. In the investigation of disorders involving hyaline cartilage MRI accurately assesses both thickness and integrity. The complete spectrum of disorders of the knee may be investigated using MRI, but familiarity with normal variants is essential in order to avoid errors in interpretation. As a result of undergoing MRI some patients may be saved surgical intervention whereas others may be able to benefit earlier from operations which are indicated.

Notes

Paediatric Studies (4.35–5.15)

The role of radionuclides in renal imaging in children: a review

H. Carty
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While there is now a general appreciation of the differing roles of static renal imaging and functional studies in adults, there is still uncertainty, particularly among paediatricians, as to the most appropriate radionuclide imaging study in children with renal problems. The indications for each study, its timing, its advantages and disadvantages, are reviewed in relation to the clinical problems of infection, obstruction, dilatation and trauma. The place of radionuclide cystography is discussed. The role of radionuclide imaging in the management of renal disease in childhood is presented in relation to other imaging techniques.

Dynamic CT in young children (chest and abdomen)

B. J. Cremin
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Abstract not received.

Ripley Suite

Renal Studies (9.00–10.15)

Ultrasound in paediatric renal disease

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The prenatal ultrasound diagnosis of congenital urological abnormalities is now well established, with an incidence of approximately 1500 pregnancies nationally. The role of prenatal ultrasound lies in identifying severely affected fetuses, and, perhaps more importantly, in identifying fetuses requiring further investigation postnatally which would otherwise pass undetected. Over an 8-year period 286 neonates with an antenatal diagnosis of hydronephrosis have been referred to the Hospital for Sick Children. The ultimate diagnosis has broadly fallen into six groups: pelvi-ureteric junction obstruction, mega-ureter, vesico-ureteric reflux, multicystic kidney, posterior valves and duplex systems. The ultrasound diagnosis is reviewed, together with current thinking and trends in postnatal management.

Ultrasound diagnosis of horseshoe kidney

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In recent years, ultrasound has replaced intravenous pyelogram (IVP) as the primary imaging method in several renal tract disorders. However, several congenital malformations of kidneys, including horseshoe kidney, which are readily diagnosed by IVP may evade detection by routine ultrasonic examination. Sonographic diagnosis of horseshoe kidneys depends on the demonstration of an isthmus of renal tissue situated in front of the great vessels in the upper abdomen connecting the lower poles of the kidneys. In a number of cases, the bridge of renal tissue may be replaced by a fibrous band which may not be demonstrated by ultrasound, or this tissue may be misdiagnosed as lymph nodes or pancreatic tissue. We report ultrasonic findings in a series of 11 patients with horseshoe kidneys, confirmed by IVP examinations. In seven patients isthmus of renal tissue was demonstrated by US but in all 11 cases, the renal outlines appeared "inverted triangular" or "inverted pyriform" in shape, instead of normal ovoid or reniform outline. Detection of "inverted triangular" or "inverted pyriform" shape of the kidneys should raise suspicion of horseshoe kidney. The mid-line of the upper abdomen should then be meticulously scanned for detection of isthmus of renal tissue. If negative, IVP should be carried out.

Contrast clearance: a new method for the measurement of glomerular filtration rate

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The clearance of standard iodinated contrast media can be measured during contrast examinations using an X-ray fluorescence technique. We present an evaluation of this new, simple and potentially accurate method for the measurement of glomerular filtration rate (GFR). To test accuracy and reproducibility, repeat analysis of 12 standard iodine solutions was performed throughout the study period. Iohexol clearance was compared with inulin and Tc-DTPA clearances using both classical renal and single injection plasma clearance methods. An overall 2% variation in iodine concentration measurement was observed over the working range. The classical renal clearances of inulin and iohexol compared favourably (r=0.99; mean difference 2.6 ml/min). Single-injection contrast clearance correlated closely with single-injection $^{99}Tc^{m}$-DTPA clearance (r=0.97: mean ratio 0.98), as did a single-sample single-injection method, the simplest for clinical purposes (r=0.94, mean ratio 1.02). Contrast clearance is a simple and accurate method for the determination of GFR. This may be performed alone or in conjunction with urography to make a truly functional examination.

The effect of hydration on the non-ionic intravenous pyelogram

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Sixty-one patients undergoing intravenous urography with non-ionic contrast medium (iohexol 350 mg/ml) were included in this prospective study designed to assess the effect of hydration on pelvicalyceal distension and pyelogram density. Patients were allocated randomly to one of two groups. The first group was instructed to take no fluids for 6 hours prior to the examination, the second group was given no instructions regarding fluid intake, and received 300 ml of water orally 5–10 min before the examination. Abdominal compression was not employed. The radiographs produced were assessed by an experienced observer (A.J.M.) who was unaware of the state of hydration. No significant difference in the degree of pelvicalyceal or ureteric distension was demonstrated between the two groups. However, the density of the pyelogram was significantly poorer in the hydrated than the fluid restricted group ($p \leq 0.005$). We conclude that when using non-ionic contrast medium prior fluid restriction remains an important part of the technique.

The most advantageous timing of external ureteric compression during intravenous urography

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The objective of this study was to ascertain the most advantageous timing during an intravenous urogram, to apply external ureteric compression, so as to gain the greatest calyceal distension. This was a prospective randomized trial of 60 patients, divided into three equal groups, having compression applied: immediately after injection, at 5 minutes and after the 5-minute film had been viewed. Patients with the usual exclusion criteria for compression were not included in the study. A statistically significant improvement in the calyceal distension occurred when the ureteric compression was applied at 5 minutes compared with compression applied after the 5-minute film had been viewed. No improvement in distension was seen when the compression was applied immediately after injection. We recommend that, except in patients with the usual exclusion criteria, external ureteric compression should be applied immediately after the 5-minute film has been taken to achieve optimal calyceal distension.

The intravenous urogram: an appropriate use of resources?

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The demand for radiological services continues to increase and critical analysis of current radiological practice is necessary to ensure that limited resources are used effectively. This study was designed to investigate the use of intravenous urography (IVU) in a large teaching hospital. The request cards of 643 IVUs performed during a 6-month period were reviewed retrospectively. Details concerning (a) the source of referral, (b) clinical indication for IVU and (c) presence of a significant abnormality on the IVU were abstracted. Note was also made of the number of chest radiographs requested with the IVU, and any abnormality demonstrated. Relevant abnormalities were demonstrated in 16.5% of the IVUs analysed. An IVU is essential in the investigation of haematuria, loin pain and known urothelial tumours. Its use is not always appropriate in other conditions including prostatism, urinary tract infections, testicular complaints and non-specific abdominal pain. It was estimated that at least 54% of IVUs were probably unnecessary. If more appropriate use of the IVU could be established by implementation of guidelines drawn up in conjunction with clinical colleagues, savings of £32 000 per annum could be achieved. However, as alternative investigations (ultrasound, radionuclide renogram, etc) may be required, not all these savings would be realized. Chest radiographs were requested and performed in 30% of the patients, but a significant abnormality was present in less than 1%. An additional saving of £2000 could be made if the practice of performing "routine" chest radiographs with IVUs was abandoned. With more selective and appropriate use of IVUs, not only could financial savings be made, but exposure of patients to potential reactions to IV contrast medium and unnecessary ionizing radiation could be reduced.

The role of MRI in the early post transplant kidney

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The search for an accurate imaging modality to diagnose renal allograft rejection has intensified in recent years. In view of this we report on a recent prospective study of 20 patients (25 cases) assessing the role of MRI in the diagnosis of acute rejection. All patients included in this study were within 3 months of transplantation and had either primary non-function or secondary dysfunction. Obstruction and

urinary tract infection had been previously excluded. Twenty-five ultrasonic scans, 20 of them with Doppler, were also performed, and these results compared with the MRI findings. MRI examination was carried out using a 0.15 Tesla resistive magnet. Both TE40 (T_1-weighted) and TE80 (T_2-weighted) sequences were performed. The diagnosis of acute renal allograft rejection was based on loss of corticomedullary differentiation and/or poor vascular supply. The final diagnoses, which included acute rejection, ATN and cyclosporin toxicity, were based on a combination of clinical review, cyclosporin levels and histology. Both MRI and ultrasound correctly identified the diagnosis in 70% of cases, but preliminary results suggest Doppler US may be superior to either.

A comparison of renography and IVU for urological assessment of spinal cord injury patients

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Genito-urinary complications are the principal cause of morbidity in spinal cord injury patients. Prevention of these complications with preservation of renal function is a fundamental goal of management. This requires repeated patient assessment, conventionally using urography to image the renal tract. We have compared the results of IVU and radionuclide renography in the assessment of 33 patients with spinal cord injury. After initial assessment by both methods, cases were followed up for up to 6 years by conventional means. The upper renal tracts were shown by both methods to be normal in 18 and abnormal in eight patients. Important abnormalities (calculi and diverticula) were diagnosed by IVU only in six cases. Seven patients had abnormal renography but normal IVU, three of whom subsequently developed abnormalities. No subsequent abnormality developed following normal renogram and IVU. We conclude that renography combined with kidney, ureter and bladder offers a suitable interim method for the assessment of spinal cord injury patients after initial IVU. This has the advantage of lower cost and radiation burden.

Magnetic resonance imaging of renal masses

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Investigation of renal masses with magnetic resonance imaging (MRI) is being studied. Thirteen cases have been examined to date: two hamartomas, one transitional cell carcinoma, one renal vein thrombosis and nine renal cell carcinomas. MRI (coronal: TR 860 ms, TE 26 ms; transverse: TR 860 ms, TE 26 ms and TR 1900 ms, TE 30 ms, T_1 100 ms) accurately demonstrates the inferior vena cava (IVC) in all cases, delineating the full extent of thrombus and/or tumour invasion. In patients with renal cell carcinoma, CT suggested IVC invasion in four cases. MRI confirmed this in three (with more acute delineation); in the fourth MRI showed the IVC to be compressed but patent. MRI demonstrated invasion beyond perinephric fat in five cases; in one MRI and CT appear to have overstaged the disease compared with surgery. In one other, involvement of multiple vertebral bodies was not demonstrated on CT. In four patients MRI, in agreement with surgery, showed no invasion beyond perinephric fat. In one CT had suggested possible hepatic invasion. In conclusion, MRI accurately stages renal cell carcinoma, especially with respect to vascular and bone involvement. It is at least as accurate as CT for assessment of local invasion, rendering CT unnecessary where MRI is available.

$^{99}Tc^m$-MAG3 compared to conventional radiological investigation in paediatric renal tract disease

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Our experience of $^{99}Tc^m$-mercapto-acetyl-triglycine ($^{99}Tc^m$-MAG3), a new Hippuran substitute for renography and indirect micturating cystography (iMCUG), in the investigation of 75 infants and children with renal tract disease is reported. A retrospective analysis of clinical details and radiological investigations was made, comparing $^{99}Tc^m$-MAG3 results with those of other investigations. Sixty-one patients had ultrasonic scanning, 31 conventional MCUG, 30 intravenous urograms (IVU) and 27 $^{99}Tc^m$-DMSA scans. Referrals were for: investigation of urinary tract infections (UTI) (39); surgical assessment (17); investigation for antenatally diagnosed renal tract disease (11); multiple congenital defects (4); screening asymptomatic patients (2); and loin pain (2). Twelve patients had concurrent $^{99}Tc^m$-DMSA scans with 6 scarred kidneys, four of which were identified on $^{99}Tc^m$-MAG3 parenchymal images, and in two differential renal function was reduced by more than 10%. The latter two criteria, when taken together with reflux as demonstrated by iMCUG, gave a sensitivity for renal scarring in the UTI group of 92% and specificity 85%, compared to 50% and 86% respectively for ultrasound alone. All significant lesions identified by ultrasound and IVU in all groups were also identified by $^{99}Tc^m$-MAG3. $^{99}Tc^m$-MAG3 gave more information than any other single imaging modality, is safe and sensitive for the investigation of childhood renal tract disease and may reduce the need for other investigations with higher radiation doses.

Bramham Suite

Radiotherapy Papers (10.45–12.00)

Intraluminal brachytherapy in bronchial carcinoma

R. Stout, P. V. Barber, P. A. Burt, B. R. O'Driscoll and M. Notley
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External beam radiotherapy is the established treatment for the relief of respiratory symptoms in patients with inoperable non-small-cell bronchial carcinoma. Although beneficial, it usually produces a temporary oesophagitis and permanent lung fibrosis. Endobronchial brachytherapy is attractive because it can spare the surrounding normal tissues from the early and late effects of radiation. It has never gained widespread acceptance because of the significant complications associated with interstitial implantation and the long treatment times and radiation protection problems inherent in low-dose-rate intraluminal therapy. The development of high-dose-rate remote afterloading equipment using a miniature high-activity source has now solved the problems of endobronchial irradiation. Treatment is given to patients admitted for the day, using fibreoptic bronchoscopy under local anesthesia to identify the tumour and position the intraluminal applicator. A miniature (1.1 mm diameter) 10 Ci iridium source is remotely despatched along the applicator using the high-dose-rate Micro Selectron. 15 Gy is prescribed at 10 mm from the source and treatment delivered in 10–20 min. Our pilot study of 150 patients has demonstrated that durable palliation can be achieved when intraluminal irradiation is used alone as the primary treatment. Cough improved in almost 60%, breathlessness in 70% and haemoptysis in 90%. Re-expansion of pulmonary collapse was obtained in almost 50%. No significant morbidity was observed. Intraluminal radiotherapy is now a simple, safe and effective palliative for selected patients with inoperable lung cancer, achieving results comparable to conventional X-ray therapy with less morbidity.

Pelvic insufflation: a method of displacing small bowel during radiotherapy to the pelvis

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Failure to cure common gynaecological and urological malignancies is frequently due to recurrence confined to the pelvis. Increasing the dose of conventional radiotherapy leads to a greater incidence of small bowel damage. We have attempted to overcome this by introducing gas into the peritoneal cavity to displace small bowel from the pelvic radiation field immediately prior to radiotherapy in five patients with advanced cervical carcinoma. Three litres of nitrous oxide is introduced into the pelvis over 3 min via an implanted Tenckhoff cannula, with the patient tilted head down to force the gas to rise into the pelvis, displacing the bowel downwards. Conventional radiotherapy is given with the patient on a 15° polystyrene slope to maintain displacement. Deflation occurs over 60–90 minutes. Displacement of the bowel is assessed by weekly simulator films with barium. Reproducible displacement of the small bowel was achieved with minimal discomfort during the procedure. Acute radiation reactions were mild. Only 10 min of additional staff time was required per day, with no increase in setting-up time. Dosimetry is discussed.

Use of an electron beam for post-mastectomy radiotherapy: 5-year follow-up of 500 cases

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From 1982 onwards, the standard method of regional radiotherapy post-mastectomy at this institute has used a single electron field of fixed energy (8 MeV) to irradiate the chest wall, matched to a single megavoltage field (4 or 8 MV) irradiating the nodal areas in the axilla and supraclavicular fossa. (A separate parasternal field was *not* used). All 500 cases treated in 1982 and 1983 with this method were reviewed (median follow-up 59 months), 422 referred directly post-mastectomy and 78 for local recurrence after previous mastectomy. Of these, 42 were treated palliatively, and 458 with radical intent. In radical cases the given dose in both fields was 40 Gy in 15 fractions in 3 weeks. At 5 years the overall survival (n=458) was 51% and the local recurrence rates by site and UICC stage were as follows: chest wall: all 18%, Stage I 4%, Stage II 13%, Stage III 26%, recurrent cases 21%; axillary recurrences: all 20%, Stage I 4%, Stage II 10%, Stage III 22%, recurrent cases 39%; supraclavicular recurrences: all 9%. Only one patient of the 500 treated had a parasternal recurrence. Late effects included telangiectasia in the electron field and asymptomatic apical lung fibrosis in the photon field. There was no match line fibrosis.

Strategy for the use of highly focussed ultrasound for the non-invasive destruction of deep seated tumours *in vivo*

G. R. ter Haar, I. Rivens, R. L. Clarke and C. R. Hill
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Highly focussed beams of ultrasound of sufficiently high intensity may be used for the selective destruction of tissue volumes at depth in tissue, without damage to overlying regions (ter Haar et al, 1989). We are investigating this technique for the non-invasive treatment of discrete liver and bladder tumours. A system has been designed and built that enables the focus of an ultrasonic beam to be moved around any given point in tissue in a controlled fashion, and thus to destroy a predetermined tissue volume. This system has been successfully tested both in pig's liver *in vitro* and in pig thigh muscle *in vivo*. In pig's thigh, a cube of tissue 2 cm x 3 cm x 1 cm lying 7 cm below the skin surface was successfully destroyed. Simultaneous diagnostic ultrasound imaging allows visualization of the damaged tissue volume in real-time. Tissue volumes that are ellipsoid in shape (1.5 cm x 5 mm) are damaged at each focal position of the beam. The strategy for damaging larger tissue volumes will be discussed in terms of exposure times (commonly 1–20 s), proximity of adjacent lesions and the planning of the positions in which successive lesions should be placed, since the presence of a lesion may alter the tissue acoustic properties and thus the exposure conditions for adjacent lesions.

Reference

TER HAAR, G. R., SINNET, D., RIVENS, I., 1989. High intensity focused ultrasound — a surgical technique for the treatment of discrete liver tumours. *Physics in Medicine and Biology, 34*, 1743–1750.

Radiotherapy for cerebral oligodendroglioma in adults: an analysis of 98 cases and the dose-reponse relationship

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Ninety-eight adults aged 16–69 years received megavoltage cranial irradiation for oligodendroglioma at the Christie Hospital between 1965–88. The influence of radiotherapy on local control and survival, and the dose-response relationship, were analysed. Patient characteristics (age, sex, condition, mode and duration of presentation), site of disease, surgical technique, duration of delay to radiotherapy, and irradiation technique were examined for prognostic significance. The fractionation schedule employed and the Karnofsky Performance (KP) score before starting radiotherapy were the only factors which influenced outcome. After a median follow-up of 48 months, the best results were obtained in a group of 38 patients with a KP score of 80 and over who received 37.5–42.5 Gy in 16–18 fractions: in this group, 68% survived 5 years and 33% survived 10 years. The results obtained for the whole group were 39% at 5 years and 19% at 10 years. The median time to recurrence after radiotherapy was 44 months and all patients whose disease recurred died within 38 months. The literature was reviewed and comparisons with our results are discussed. We conclude that optimally fractionated radiotherapy to brain tolerance is beneficial as it improved the overall and relapse-free survival.

Visual loss in the irradiated eye — an incidence study of 42 cases

S. F. Leung and S. Y. Ts'ao
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Forty-two patients with locally-advanced nasopharyngeal carcinoma were treated with a radiotherapy plan which involved sacrificing one of the eyes. The globe, the optic nerve and part of the lacrimal gland were included in the high dose zone. The dose–fractionation was either 60 Gy/26 fractions/6 weeks or 66 Gy/33 fractions/6.5 weeks. The actuarial risks of severe visual loss in the irradiation eye at 1 year, 2 years and 3 years after radiotherapy were 4%, 15% and 30%, respectively.

Langerhans cell histiocytosis (LCH): its morbidity and mortality

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The morbidity resulting from LCH and its treatment is poorly defined. We evaluated outcome in 59 patients treated at the Christie Hospital and Royal Manchester Children's Hospital between 1944 and 1987. Median follow-up was 76 months. Sixty-nine bone lesions were irradiated in 48 patients and 67 responded. Hypothalamic pituitary axis irradiation did not reverse diabetes insipidus (DI) in the four patients treated. In 7/9 cases treated, extraskeletal lesions responded to local irradiation. There was no relation between dose and outcome. Cytotoxics were successful in arresting extraskeletal pathology in 10/23 patients. Five patients have residual skeletal deformity, two had received irradiation. All 12 patients with DI require DDAVP and one has growth hormone deficiency. Persistent oral LCH has resulted in dental morbidity in one child; another has recurrent soft tissue disease in the infratemporal area. Both had irradiation. No patients with skeletal pathology alone died; 10 with extraskeletal manifestations succumbed to progressive disease, and there was one intercurrent death. Overall 5-year survival is 80%. Three patients have had successful pregnancies. No second malignancies have occurred. We conclude: (1) major soft-tissue/skeletal defects are uncommon in long term survivors; (2) regular endocrine assessment is required; (3) optimal management of extraskeletal LCH needs defining.

Notes

Ripley Suite

Liver and Abdominal Studies (2.30–3.45)

Liver transplantation: the role of ultrasound

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Orthotopic liver transplantation is now an accepted treatment for end-stage liver cell failure. The combined programme in King's College Hospital and Addenbrooke's Hospital, Cambridge has now carried out 600 transplants. Radiology has played a crucial part in the development of the programme, and in the improved survival rate achieved, through its role in judicious patient selection, and also in early detection and treatment of complications following liver grafting. Ultrasound is important in assessment of complications related to the biliary tract and peri-hepatic collections. The operation requires a series of complex vascular anastomoses. Early occlusion of these, particularly of the hepatic artery, may have catastrophic clinical consequences, with graft infarction necessitating re-transplantation. If occurring late, graft sepsis and biliary leaks or strictures may be the clinical sequelae. Doppler ultrasound therefore plays an important role in evaluation of continuing vascular flow. To date, results of ultrasound in the diagnosis of rejection are disappointing. The role of ultrasound will be fully explored, indicating how it is integrated into the overall radiological treatment of liver transplantation.

A prospective study of colour Doppler ultrasound and isotope imaging in the detection of early renal transplant rejection.

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A prospective study of 46 renal transplant recipients (211 examinations) comparing colour Doppler ultrasound and isotope imaging in the diagnosis of acute transplant rejection was performed over a 5-month period. All patients had both examinations within two days of transplantation and further examinations as dictated by the clinical course. In 19 patients who had serial scans, 12 episodes of acute rejection were identified by definite histological changes on biopsy. Of these 12, 10 were identified as abnormal by a pulsatility index (ratio of peak systolic flow minus minimum diastolic flow divided by mean flow) greater than 1.5 and seven out of 12 were identified by isotope imaging. Four of the five false-negative isotope studies were probably related to the absence of a satisfactory baseline study. Doppler examination appeared to be particularly useful in the early post-transplant period when the kidney is poorly perfused, leading to difficulties in interpreting the isotope results. In conclusion, Doppler examination and isotope imaging are valuable and complementary techniques for the detection of early complications following renal transplantation.

Cholangiography in liver transplantation

P. Holland and E. Morris
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Cholangiography is an important part of the post-operative assessment of patients who have undergone liver transplantation. In our centre, more than 315 liver transplants have been performed since 1982. We have reviewed over 250 of these patients, assessing the T-tube cholangiograms, percutaneous transhepatic cholangiograms and endoscopic retrograde cholangiograms. The normal appearances of the various biliary reconstructive procedures are demonstrated. Some 30% had no biliary tract evaluation because they died soon after the operation. In the remainder, more than 550 cholangiograms were reviewed, together with any biliary interventional procedures undertaken. The commonest complications were biliary leakage (17.5%) and stricture formation with or without significant obstruction (10.5%). In many cases, the two complications were related. T-tube migration occurred in 2.7%. Other complications, including sludge and stone formation, accounted for 3%. Biliary interventional procedures were performed in a number of patients, including balloon dilatation of strictures, biliary drainage, debris removal using a balloon catheter and stent insertion. The relationship between biliary tract changes seen at cholangiography following transplantation and other post-operative complications, particularly hepatic artery occlusion, rejection and abscess formation, is discussed.

Hepatic vein Doppler in the diagnosis of acute liver transplant rejection

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Doppler examination of the hepatic artery and portal vein following liver transplantation is widely described. Although of great value in the diagnosis of acute vascular complications, it has played no part in the detection of rejection. In the normal liver, Doppler ultrasound of the hepatic veins gives a pulsatile waveform. There is anecdotal evidence that this pulsatility is lost in liver disease. We have explored the use of this observation in the assessment of acute liver transplant rejection. Thirty-seven liver transplants in 31 patients (aged 1–20 years) were studied for up to four weeks after transplantation. Routine ultrasound and Doppler examinations of the transplanted liver and hepatic vessels were performed within the first 48 hours and then at 2–3 day intervals. There were 23 biopsy-proved rejection episodes. Eighteen of these were correctly diagnosed before biopsy by a reduction in hepatic vein pulsatility. The five missed periods of rejection occurred in patients in whom the waveform was already severely damped by peri-operative ischaemia or preservation injury. There were no cases of proved rejection with normal hepatic vein Doppler traces. Most importantly, the changes in pulsatility may precede clinical or biochemical evidence of rejection by up to 36 hours. The earlier diagnosis of rejection enables treatment to be started sooner, improving the possibility of graft survival.

More complications of intra-arterial hepatic perfusion catheters: the radiological appearances of perfusion catheters which migrated outside the hepatic artery

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Direct infusion of chemotherapeutic agents into the hepatic arterial system has become a popular method of treatment of unresectable liver metastatic disease. The method involves placing a cannula at open operation with its tip within the hepatic artery and its end connected to a subcutaneous porte (Porte Cath TM) through which direct injection of cytotoxic agents can be made. This method has become an effective alternative to systemic chemotherapy as it has a lower incidence of systemic side effects than other routes of administration, and better patient compliance. However, it is not without side effects, both local and systemic, some of which are potentially life-threatening. Side effects already described include a chemically induced hepatitis, gastric and duodenal mucosal damage, small bowel perforations and biliary strictures. Factors postulated in the development of these complications include ischaemia induced at the initial operation to place the catheter, a chemical arteriolitis, and direct mucosal irritation by the catheter. We present three cases of catheter migration out of the artery into surrounding structures, caused presumably by a combination of the above factors. We present the radiological appearances of these complications, including CT and ultrasound, and show the importance of radiology in diagnosing these complications.

Know your physics and avoid a pitfall

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Posterior echo enhancement is rightly considered to be a reliable indicator of a fluid-filled lesion. This is because the fluid attenuates the ultrasound beam much less than the surrounding tissue, so echoes deep to this fluid-filled lesion are enhanced. This appearance may also be observed when two areas of soft tissue of markedly different attenuation values lie side by side. Fatty liver attenuates the liver more than normal liver or soft tissue; therefore a metastasis within fatty liver will show posterior echo enhancement compared to the neighbouring tissue. We show examples of these phenomena, together with similar appearances produced by intra-hepatic abscesses. We discuss practical ways of recognizing this and differentiating the two, and demonstrate that an understanding of physics helps in the interpretation of images and in avoiding pitfalls.

Notes

Perfluorooctylbromide (PFOB) as a contrast agent for liver and spleen enhancement in computed tomography

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Perfluorooctylbromide (PFOB) 100% emulsion is a radio-opaque fluorocarbon which is taken up by the liver and spleen when given intravenously. A trial of PFOB was carried out on 18 patients with malignancy and distal metastases, using doses ranging from 0.5 g/kg to 3.0 g/kg. Enhancement of liver up to 29 HU, spleen up to 318 HU and blood pool up to 55 HU was achieved, using 96 kV. Except for rim enhancement in two cases, there was no detectable enhancement of primary or metastatic tumours. PFOB increased the visibility of liver metastases and revealed smaller metastases less than 1 cm in diameter not visible prior to contrast injection. Scans taken at 24 hours after contrast medium showed improved definition of metastases but because enhancement of veins was absent, interpretation was more difficult. A rapid fall in blood pool enhancement was attributed to strong splenic sequestration of emulsion following infusion of contrast. PFOB is a significant improvement on existing contrast media, because it gives more prolonged blood pool enhancement, and is selectively taken up by the liver and spleen.

The recognition of abdominal scars at computed tomography

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Accurate knowledge about previous surgical procedures is of paramount importance when reporting computed tomographic (CT) studies of the abdomen. Sadly, the referring clinician does not always provide this information along with the clinical details. It might be argued that careful scrutiny of the images should reveal scars in the anterior abdominal wall and other effects of surgery. To test this hypothesis, we have studied 50 consecutive patients undergoing CT of the abdomen and pelvis. The radiologist performing the CT study examined the patient's abdomen for scars and established the nature of any previous surgery by discussion with the patient. A second radiologist, who was unaware of the patient's clinical details, reviewed the CT images at the console and predicted whether there had been any previous surgery. These predictions proved inaccurate; only 60% of scars were recognized. Although the absence of major organs was reliably reported, even large paramedian scars were missed. Most of the Pfannenstiel's incisions were missed, despite recognition of an absent uterus. Old scars were missed more frequently than recent scars. The results re-emphasize that accurate clinical details, including those of previous surgery, are necessary when interpreting abdominal CT.

Percutaneous gastrostomy in children

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Percutaneous gastrostomy is now an accepted alternative to surgical gastrostomy. Our experience with percutaneous gastrostomy in adults, in whom we found it a simple, effective, safe and well tolerated procedure, led us to explore its value in children with various nutritional problems. We have used the technique now on six children, five with cystic fibrosis and one with presumed Behçets disease. All procedures were performed under local anaesthesia and intravenous sedation. The day before, a cup of barium was given to outline the colon. Buscopan 20 mg IV was given to paralyse the stomach. The stomach was inflated with air either via an endoscope or NG tube. The stomach was fixed to the anterior abdominal wall using one T-fastener. Direct puncture of the anterior gastric wall with a Seldinger needle was followed by guide-wire insertion and dilatation to accept a thin-wall catheter, *e.g.* Freka, which was left in the stomach or directed into the proximal jejunum. The procedure has been well tolerated by all the children and there have been no complications. Dramatic improvements on the centile weight charts have been recorded. We conclude that percutaneous gastrostomy is a safe technique which can significantly improve nutrition in children with GI disorders like cystic fibrosis.

Abdominal CT scanning in AIDS

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Abdominal CT scans were carried out in 35 patients with AIDS. Twenty scans (57%) were abnormal. Several patterns of abnormality were noted. *Mesenteric/para-aortic lymphadenopathy:* this was usually a result of lymphoma or atypical mycobacterial infection; occasionally the appearance results from Kaposi's sarcoma; *focal liver lesions*: these were again a result of mycobacterial infection or lymphoma; *biliary abnormalities*, owing to cryptosporidial infiltration. Ultrasound examinations and biopsies were performed in the majority of patients. Correlation with CT findings is presented.

Vascular Ultrasound Studies (4.15–5.30)

Colour flow imaging principles

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The visualization of blood flow using colour flow imaging systems may provide useful diagnostic information that cannot be acquired as easily by other techniques. However, in order to make best use of this diagnostic information, it is necessary to consider the fundamental principles of the technique and its limitations. Colour flow imaging systems utilize a pulsed Doppler technique to determine the velocity of flow, and are therefore subject to the same limitations. Pulse pair co-variance estimation is used to analyse the Doppler signal, rather than the slower FFT analysis, because of the large number of velocity determinations required in the construction of a colour flow image. This method, which estimates instantaneous mean velocity, variance of the mean and the direction of flow, introduces additional limitations. Shades of red and blue are used to code for the flow direction towards or away from the transducer, respectively. Increasing velocities are coded as increasing intensity of colour and the variance of the mean velocity estimate, which represents flow disturbance, is coded by mixing green into the colour spectrum.

Colour Doppler evaluation of prosthetic cardiac valve function after exercise

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Early prosthetic valve dysfunction can be diagnosed by Doppler echocardiography. The sensitivity of this technique is increased by performing studies after exercise, yet there are few studies assessing the residual gradients across normal prosthetic valves in this situation. In a prospective study we have carried out colour Doppler examinations in the post-operative period on patients undergoing valve replacement. A variety of aortic and mitral prostheses were studied, both before and after exercise. Eighty-six valves were studied in all, and the examination technique is described. Residual gradients vary with the type of valve used and figures for various types of prosthesis are presented. One previous study has found significant increases in pressure gradients across mitral prosthetic valves with exercise but we have found no significant change in residual gradient or peak flow velocity for any one of the types of prosthesis studied, in either aortic or mitral position. Any significant observed increase in these values on exercise almost certainly represents true dysfunction of the prosthesis.

Notes

Progress of treated deep venous thromboses: evaluation with colour Doppler ultrasound

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Colour Doppler ultrasound has recently been shown to be an accurate imaging modality in the diagnosis of lower-limb venous occlusive disease. Being a safe and non-invasive technique it affords the potential advantage of monitoring patient response to treatment. Twenty-five patients with lower-limb venous thrombosis, diagnosed both on venography and colour Doppler examination, were re-scanned at intervals of 1, 3, and 6 months. Flow characteristics both spontaneous and augmented with distal compression, were observed. Intraluminal echogenicity, partial recanalisation of thrombus, vein distensibility and collateral circulation were also assessed. The relationship of these findings to the treatment time was noted. Post-phlebitic changes, which are discussed, appeared to persist in the vast majority of cases. Awareness of these changes may help avoid misdiagnosing chronic post-phlebitic change as acute deep venous thrombosis.

Dextricity and carotid plaque lesion

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The relationship of handedness to the size and spread of carotid plaque lesions was evaluated using B-mode real-time ultrasound studies in 80 patients. Eight were left-handed and 72 were right-handed. Most left-handers (75%) had more carotid plaque lesion in the left carotid arteries, most right-handers (75%) in the right. The odds of having more plaque on the side ipsilateral to handedness were more than nine times greater than the odds of having more plaque lesion on the opposite side (p=0.001); after controlling for age, sex, race, hypertension and smoking. The results are discussed with reference to changes in cerebral blood flow.

Duplex scanning and non-invasive impedance analysis to detect the "at-risk" femoro-distal graft

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Computer-assisted impedance analysis is a new technique, which may help identify "at-risk" femoro-distal grafts prior to failure. Pulsatile pressure and flow within the graft are determined non-invasively. Transfer analysis is performed on the paired pressure/flow signals and an impedance score derived. Fifty patients with functioning, non-reversed femoro-distal vein grafts were studied. Each graft was assessed using duplex scanning, impedance analysis and intra-arterial digital subtraction arteriography. Grafts were defined as "at-risk" (22) or control (28), dependent upon arteriographic evidence of graft or run-off stenoses over 50%. Duplex scanning successfully predicted all seven proximal/mid-graft stenoses, but only four of 16 distal graft/run-off lesions. Impedance scores were significantly increased in the "at-risk" grafts (0.58 + [0.43–0.72]*), when compared with the control grafts (0.34 + [0.30–0.38]*). An impedance score of over 0.45 was able to predict stenoses over 50% with a sensitivity, specificity and predictive value of 87%, 96% and 93% respectively. Duplex scanning is an excellent technique for the detection of proximal/mid-graft stenoses. When the stenosis is at, or below, the level of the knee, impedance studies have the advantage. These results are reproducible and show that the non-invasive measurement of limb impedance has a role in the detection of "at-risk" femoro-distal grafts.

*Means + 95% confidence intervals, p<0.001 Mann–Whitney U test

The value of combined venography: comparison with contrast venography

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This study was performed to validate the combined study of flow radionuclide venography (FRV) with subsequent $^{99}Tc^{m}$ RBC blood pool venography (BRV) for the detection of deep vein thrombosis (DVT). FRV was performed by using three separate doses of large $^{99}Tc^{m}$04- bolus (6–10 ml) injection. Findings of 32 patients with suspected DVT of lower extremities ($n = 52$) were compared with those of corresponding contrast venography (CV) serving as a reference method. Our findings were as follows:

	CV and FRV		CV and BRV		CV and FRV + BRV	
Vein	Agree	Disagree	Agree	Disagree	Agree	Disagree
Iliac	98%	2%	98%	2%	98%	2%
Femoral	96%	4%	71%	29%	96%	4%
Calf	67%	33%	60%	40%	73%	27%

In 7.6% extremities, collaterals not demonstrated by CV were seen by only FRV. Although radionuclides were injected into a relatively large volume, all the calf veins could not be filled even when they were completely patent. Conclusions: (1) although a combined study of FRV with BRV improved the diagnostic value of radionuclide venography for the detection of DVT in calf veins, CV is a mainstay in this region unless it is contraindicated, and (2) CV can be replaced by FRV without combination with BRV for the detection of DVT in femoral and iliac veins.

The use of duplex derived hyperaemic flow to detect femoro-distal graft related stenoses

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The identification of "at-risk" femoro-distal grafts has been investigated in 40 patients using duplex derived volume flow. Two hyperaemic stress tests (I: an occlusive cuff 50 mm Hg above systolic pressure for 2 minutes; II: active ankle flexion for 2 minutes) were assessed and the results expressed as the mean percentage rise from the resting value + 95% confidence interval. Grafts were defined as "at-risk" or control, depending on the presence or absence of graft or run-off stenoses greater than 50% following intra-arterial digital subtraction arteriography.

	Controls	"At-risk"
Number of patients	22	18
Mean resting flow (Q)	122 + (87–57)	161 + (115–207)
Test I (% rise Q)	647 + (343–950)	169 + (85–253)**
Test II (% rise Q)	434 + (51–816)	149 + (60–238)*

Whereas resting flows were similar, there was a significant difference between the groups following both hyperaemic tests. A hyperaemic flow increase of greater than 200% was able to predict "at-risk" grafts with a sensitivity and specificity of 100% and 78% for Test I and 53% and 53% for Test II respectively. These results show that duplex derived volume flows are only predictive of "at-risk" grafts following the use of a hyperaemic test. The 2-minute cuff hyperaemic test is superior to active ankle flexion; it is simple to apply and can help to identify "at-risk" grafts before they fail.

*$p < 0.05$; **$p < 0.001$ (Mann–Whitney U test).

Notes

Bramham Suite

Radioisotope Diagnosis and Therapy in Oncology (9.00–10.15)

PET in oncology

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Current positron emission Tomographic (PET) scanners provide in practice a voxel spatial resolution of approximately 8 mm FWHM within a 10.5 cm section through the body. The recorded tomographic data can be corrected for tissue attenuation to provide quantitative values of regional tissue concentrations of positron-emitting radionuclides. The use of this spatial and quantitative accuracy to follow the uptake and time course of tracer molecules, labelled with positron emitters such as oxygen-15, carbon-11 and fluorine-18, allows entities of regional tissue physiology, biochemistry, pharmokinetics and targeting to be measured. This paper reviews the clinical oncological research studies currently being undertaken internationally with PET. These include measurements of tumour; blood flow ($H_2{}^{15}0$, energy metabolism ($^{15}0_2$ and ^{18}FDG), protein synthesis (^{11}C-methionine), proliferation (^{11}C-thymidine), drug deposition (^{18}F-uracil, ^{18}F-misonidazole, ^{11}C-BCNU), receptor activity (^{18}F-oestrodiol and ^{11}C-raclopride), antibody targeting (^{124}I-MCA).

Strontium-89 therapy

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Strontium-89 is a pure beta-emitter (maximum beta energy 1.4 MeV) with a half-life of 51 days. It localizes preferentially adjacent to metastatic deposits, being retained at these sites much longer than in normal bone. A number of studies have assessed its potential to control pain in skeletal metastases. The majority of patients had carcinoma of the prostate and had failed conventional therapies. Assessment was made at 12 weeks by a scoring system taking into account general condition, mobility, analgesics required and level of pain. In the British study an attempt was made to obtain a dose response but no additional benefit was seen with doses larger than 1.5 MBq/kg. A total of 131 patients were entered into this study: 75% showed improvement (21% dramatic, 32% substantial and 21% some improvement). Benefit was obtained in 10–20 days and lasted for 6 months on average. There was a suggestion that patients with fewer metastases do better, but patients obtained benefit even with very extensive disease. Apart from a few cases, in which a flare of pain was experienced shortly after injection, the only toxicity was bone marrow depression. Repeat doses of ^{89}Sr can be administered with further pain relief. It is possible to give ^{89}Sr after failure of hemi-body irradiation. Randomized studies are being undertaken comparing ^{89}Sr with external radiotherapy, both limited-field and hemi-body.

Dose-response study on thyrotoxic patients undergoing PET and radioiodine therapy

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With the acknowledged problems in assessing thyroid mass and hence radiation dose, our policy has been to give 75 MBq ^{131}I at 6-monthly intervals to patients with Graves' disease until they become euthyroid. Recently 35 patients have had their functioning thyroid mass determined from a ^{124}I PET scan, and the radiation dose to the thyroid has been calculated. The clinical response of these 35 patients has been assessed at 6-monthly intervals. The results show that patients who receive a low dose (<20 Gy) at their first treatment have a high probability (64%) of still being toxic at 18 months, independent of the number of extra treatments. In contrast, patients who receive higher doses (>40 Gy) at their first treatment have a high probability (90%) of control at 18 months. A dose of over 40 Gy needs to be delivered to minimize the chances of remaining toxic after a single treatment with radioiodine. A dose of over 60 Gy involves a 40% probability of becoming hypothyroid. In future, a PET tracer study will be performed prior to radioiodine therapy to enable a prescribed thyroid dose of 50 Gy to be delivered to patients with Graves' disease. Further ^{131}I therapy will only be considered if patients are still toxic at 12 months.

Ripley Suite

Cardiovascular Studies (10.45–12.00)

Early experiences using $^{99}Tc^{m}$-MIBI for SPECT imaging of the ischaemic myocardium pre- and post-angioplasty

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Methoxyisobutyl isonitrile (MIBI), a lipophilic compound, is becoming the preferred agent for myocardial imaging. The sensitivity of $^{99}Tc^{m}$-MIBI for detecting regional perfusion defects in patients with known coronary artery stenosis was investigated by selecting 20 patients who had stenoses of varying severity in the right coronary, left circumflex and left anterior descending arteries. The aim was to demonstrate the improvement in myocardial perfusion following angioplasty. All patients were examined using $^{99}Tc^{m}$-MIBI before and after angioplasty and the results correlated with cine-angiography and the clinical status of the patient. Various techniques were explored to obtain optimum image quality. These included: (1) 180° or 360° rotation, (2) preparation and labelling of agent, (3) preparation of patient for stress/rest protocol and (4) image display. Good correlation was present between cine-angiography and $^{99}Tc^{m}$-MIBI. It is of particular use in those cases where differentiation of myocardial ischaemia from other causes of retrosternal chest pain is difficult. It also allows prompt diagnosis of early re-stenosis without resorting to immediate angiography. The major drawback of $^{99}Tc^{m}$-MIBI is its cost. Two methods of reducing this are outlined.

Combined exercise ECG and thallium stress testing in suspected coronary artery disease

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A combined exercise ECG and thallium test is described. This was performed using a treadmill and standard protocols, with 12-lead ECG monitoring. At the end-point the patient was injected with 80 MBq thallous chloride. The heart was imaged immediately and at 4 hours to assess resting perfusion. Each left ventricular image was divided into three segments and scored. ECG stress tests were scored as positive, negative or borderline. *Results:* in 105 consecutive patients with suspected coronary artery disease there was close agreement between positive exercise tests (32) and positive thallium scans (30). Where the exercise test was negative (50), there were a significant number of positive scans (27) as well as borderline positive scans (9). These exceeded the number of negative scans (13). Patients with equivocal exercise tests (23) had positive (13) and negative (10) scans. Although the sensitivity and specificity of each test in this group of patients is not known, to date it has been found that nine patients with negative exercise tests and positive thallium scans have definite evidence of coronary disease. These results suggest that the combined exercise test and thallium scan have a high predictive value for coronary disease when both tests are positive, and that exercise testing alone underestimates the presence of coronary disease.

Notes

Monoclonal platelet specific antibody imaging in the selection of patients for peripheral arterial thrombolysis

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Arterial occlusion may be treated by intra-arterial thrombolysis, so avoiding major arterial surgery. However, for satisfactory results the thrombosis should be of recent origin and if it is of more than four weeks' duration the success rate falls. Clinical history alone is unreliable, as there may be pre-existing arterial disease, and the patients often learn to live within their disability. In recent arterial thrombosis, platelet deposition occurs which can be detected by imaging with ^{111}In labelled platelet specific antibody (^{111}In P256 Fab'). Thirteen patients with a clinical diagnosis of acute or subacute peripheral arterial thrombosis had a platelet antibody study prior to angiography and intra-arterial thrombolysis. Six patients had positive focal uptake, all were successfully lysed and 5 remained patent at 30 days. Seven patients had negative images. Six were initially lysed following thrombolytic therapy but four rethrombosed, usually on withdrawing the catheter. Only two remained patent at 30 days, one of whom was receiving drugs with some antiplatelet effects which may have interfered with deposition. This study suggests that this antibody may help to detect sites of recent arterial thrombosis and define those patients most likely to benefit from intra-arterial thrombolysis.

Misdiagnosis of an atypically located pericardial cyst with a high CT number presenting in a patient with multiple trauma

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Pericardial cysts are estimated to occur in 1/100 000 of the general population. They are usually an incidental finding on chest radiographs and show a rounded, well defined homogenous mass in the cardiophrenic angles, and in this classical site they seldom cause any diagnostic difficulty. However, in 8% of cases, they occur in an atypical site and can then be a diagnostic problem. CT is usually very helpful in these circumstances, showing a homogeneous cystic mass in continuity with the pericardium. A change in size or shape of the cyst may be seen with breathing or with the patient in the prone position. The contents of the pericardial cyst typically have a density of 5–25 HU. Very rarely, pericardial cysts can have a high CT number and this is often interpreted as a solid mediastinal tumour. We present a 17-year-old man involved in a road traffic accident who sustained major chest trauma but who unfortunately had an atypically sited pericardial cyst with a high CT number; this led to a misdiagnosis and the patient had a thoracotomy. At surgery he was found to have a cystic mass in the mediastinum containing clear yellow fluid. This was excised and was confirmed to be a pericardial cyst histologically.

CT appearances of abdominal aortic graft infection

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Prosthetic grafting of the abdominal aorta for aneurysmal or atherosclerotic disease is a relatively commonplace procedure with low mortality and morbidity rates. However, complications such as haemorrhage, anastomotic pseudoaneurysm formation, graft-enteric fistulae and graft occlusion may occur. Graft infection is one of the less common but more serious complications. Although it is important to recognize and manage this situation from an early stage, it is a difficult diagnosis to make clinically. Computed tomography is frequently performed to detect and evaluate the extent of graft infection. Accurate diagnosis of graft infection on CT requires a thorough knowledge of the normal postoperative appearance, which depends on the type of surgery employed. The clinical and CT findings in 22 patients with proven aortic graft infection, along with the normal appearances of various types of graft procedures, are presented. The role of complementary investigations is discussed.

Notes

Spontaneous dissecting aneurysm of the external iliac artery

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Primary dissecting aneurysms of the peripheral arteries are rare, as opposed to extensions from aortic dissection, which are relatively common. Significant atheromatous changes in the affected artery are unusual, with risk factors including hypertension, trauma, fibromuscular dysplasia and medial degeneration of the arterial wall. To our knowledge, only one case of spontaneous dissection of the external iliac artery has been reported previously. We present three cases of spontaneous dissection of the external iliac artery, each with discrete but characteristic angiographic features of dissection. The pathological and haemodynamic factors governing the various angiographic appearances are discussed. Dissecting aneurysm of the iliac artery should be borne in mind as a cause for acute unilateral limb ischaemia, particularly in the young or those with the appropriate risk factors.

MRI assessment of the thoracic aorta following aortic surgery

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Thoracic aortic MRI has been shown to be a particularly accurate method for demonstrating a variety of abnormalities. MRI has been advocated as a routine investigation following thoracic aortic surgery as it has been reported to demonstrate unexpected complications. We report experience which does not favour this policy. Twenty-four patients who had undergone surgery involving the thoracic aorta were examined on a 0.5 Tesla MRI scanner using ECG gated spin-echo sequences. Ten of these patients were investigated as a result of the development of new signs following surgery. The remaining 14 patients were examined either as a routine follow-up or to investigate non-specific symptoms in the absence of any change in clinical findings. In the group with new signs, significant abnormalities were demonstrated by MRI. In the 14 patients with no new signs, no significant abnormalities were demonstrated. The availability of MRI is limited. Our results indicate that if there are objective signs of deterioration following surgery involving the thoracic aorta, then MRI is worthwhile. In the absence of objective signs of deterioration, routine scanning is unlikely to demonstrate any important abnormalities which would affect management.

A retrospective study of the fate of asymptomatic superficial femoral artery stenoses

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Balloon dilatation is not currently offered to patients with asymptomatic SFA stenosis. Though it would seem reasonable not to perform an angioplasty on an asymptomatic lesion, many of us performing transfemoral arteriograms note stenoses in asymptomatic limbs which on radiological criteria would seem very suitable for dilatation. There has been no real assessment of these lesions in the literature, and with this in mind, we performed a retrospective study of patients who had transfemoral arteriography between January 1986 and June 1988. Of 521 peripheral arteriograms there were 36 asymptomatic SFA stenoses. We reviewed these patients and followed them up for between 1 and 5 years (average 2 years). Of a total of 36 asymptomatic stenoses, 22 remained asymptomatic but 14 became symptomatic, on average within 2 years, the earliest at 3 months, the latest at 5 years. Symptoms were split evenly between claudication and rest pain or ischaemic change. Of the 14 patients, three later had a balloon angioplasty, two had femoral popliteal grafts, one had a sympathectomy and four required no intervention. There were, however, two patients who came to amputation. This study looked at predisposing factors such as the brachial to ankle index, diabetes mellitus, age and smoking. We concluded that approximately one third of asymptomatic superficial femoral artery stenoses will become symptomatic within 2 years. The predisposing factors to developing symptoms appear to be a brachial to ankle index of less than 0.9% and diabetes. It would appear from our study that the fact that a superficial femoral artery stenosis is asymptomatic is no reason for complacency and no guarantee that a limb-threatening situation may not develop in the future. We have now started a prospective trial to assess these lesions.

Evaluation of stenoses by magnetic resonance jet velocity measurement

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To minimize the problem of signal loss from turbulent fluid which has hitherto precluded magnetic resonance measurement of post-stenotic jet velocities, we shortened the echo time (TE) of the field even-echo rephasing (FEER) velocity mapping sequence from 14 to 6 and 3.6 ms. Rotating disc and stenotic flow phantoms were used for *in vitro* trials, demonstrating that the 3.6 ms sequence allows MR measurement of jet velocities up to 6m/s with accuracy similar to that of continuous-wave Doppler used under optimal conditions. *In vivo* MR jet velocity measurements were made in 39 patients. Diagnoses were: partially obstructed ventriculo-pulmonary conduit (20), pulmonary, aortic and mitral valve stenoses (10), aortic coarctation (8) and Fontan procedure (2). Continuous-wave Doppler velocity measurements, available in 20 cases, correlated will with MR measurements. Catheter pressure gradient measurements (11 cases) correlated moderately well with gradients estimated, using the modified Bernoulli equation, from either MR or Doppler velocities. Fast echo MR velocity mapping is likely to have considerable importance as a non-invasive means for locating and evaluating stenoses, particularly at sites inaccessible to ultrasound, but the potential for error due to malalignment, signal loss, phase wrap and partial volume effects must be recognized and avoided.

Angiography access through vascular grafts. Is it contraindicated?

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Recent surgical literature suggests that synthetic inflow grafts to the common femoral artery contraindicate subsequent transfemoral arteriography. Many patients who have undergone inflow graft procedures will require subsequent arteriographic evaluation to evaluate the graft post-operatively, and more commonly to evaluate and treat the more distal extremity vasculature for continuing peripheral vascular disease. The purpose of this review is to compare the relative safety of transfemoral arteriography through synthetic grafts versus the alternative transbrachial approach. A review of a computer database extending over a nine year period identified 87 patients who underwent 114 arteriographic procedures where vascular access was obtained by either the brachial approach or a transfemoral approach through a synthetic graft. Twenty patients had multiple procedures. The ages ranged from 38–86 years and there were 61 men and 27 women. There were 46 transfemoral graft and 68 transbrachial procedures. Only complications relating to vascular access were included in the review. Complications were divided into major and minor categories. A major complication required either blood transfusion or operative intervention. All other complications were considered minor and included haematomas, pain, vasovagal episodes, numbness and temporary coolness or decreased pulses. Of the 46 transfemoral graft procedures, there were 12 (26%) minor and three (6.5%) major complications. Of the 68 transbrachial procedures there were 27 (39.7%) minor and two (2.9%) major complications. These differences were not statistically significant and clearly show no increased procedural morbidity related to transfemoral graft punctures. These data suggest that there is no significant difference in procedural complications between transfemoral graft punctures and transbrachial approaches. The transfemoral approach can continue to be used for vascular access in patients with synthetic grafts in the groin.

"Malignant" angiodysplasia

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Angiodysplasia, a condition of unknown aetiology consisting of microvascular abnormalities in the mucosa and submucosa, predominantly affects the caecum and ascending colon and is associated with either acute or chronic intestinal haemorrhage. Angiodysplasia is diagnosed by selective visceral angiography and/or colonoscopy, but it cannot be detected on barium enema or by the naked eye at laparotomy. The characteristic features seen on superior mesenteric arteriography include vascular tufts on the antimesenteric border of the bowel in the arterial phase, an early-filling draining vein and a slowly emptying, dilated intramural vein. However, these features are not pathognomonic and can be demonstrated in other conditions including inflammatory bowel disease and malignancy. We report four patients in whom angiography revealed features suggestive of angiodysplasia but in whom malignancy was present. In three cases the lesion was a primary carcinoma and in one a metastasis. Retrospective review of the barium studies revealed the tumour in three cases; the fourth patient was known to have a teratoma with lymph-node metastases. In all cases the angiographic appearance was indistinguishable from angiodysplasia. This stresses the importance of viewing the caecum and right colon either at colonoscopy or double-contrast barium enema before the diagnosis of angiodysplasia is accepted, particularly if conservative management is to be adopted.

Bramham Suite

Quality Assurance and Protection (2.30–3.45)

Use of ionizing radiation by non-radiologists

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The Ionizing Radiation Regulations 1988 state that all individuals who clinically or physically direct the exposure of patients to ionizing radiation are required to have attended an approved course in radiation protection. We have conducted a survey of hospital doctors in Leicester to identify those groups that use ionizing radiation and need appropriate training to comply with the regulations. A questionnaire was also included with the survey to establish the base-line knowledge of radiation physics amongst non-radiologists. The survey and questionnaire were sent to all hospital doctors in Leicester of registrar grade and above. The main groups using X-ray screening were general and vascular surgeons, anaesthetists and physicians with an interest in thoracic medicine and cardiology. The great majority of these doctors had not received any training in radiation protection but nearly all were willing to attend a suitable course. Knowledge of radiation physics and protection varied widely amongst the respondents with a significant percentage making fundamental basic errors. The detailed results are discussed, together with proposals for future training in radiation protection.

Factors affecting the radiation dose to the lens of the eye during cardiac catheterization procedures

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Regional Department of Medical Physics and Bioengineering, Christie Hospital and Holt Radium Institute, Manchester M20 9BX

Concern has been expressed about the relatively high radiation doses to the lens of the eye received by the operator during cardiac catheterization studies. Under high workload conditions and without adequate protective measures, the operator may exceed the "classification level" for the lens of the eye. A study was undertaken to assess the occupational doses received by cardiologists, to examine the factors that affect the individual's eye dose and to find a practical relationship between occupational doses and workload. Nineteen cardiologists at three centres were studied. During the study each cardiologist was provided with forehead dosemeters by individual centres and their workload was recorded. Full equipment performance measurements were performed on the five X-ray units. One centre recorded data from a Diamentor for each operator and this has been compared with the individual's eye dose, to assess its usefulness as an indicator of total workload and to compare the techniques used. Scatter experiments using a phantom were performed to compare operator eye doses during typical fluoroscopy and cineangiography exposures for each unit. Some unexpected variations in eye dose due to equipment type, dose rate, individual operator's workload, technique and experience were noted. The results are presented and discussed.

Notes

Evaluation of implementation of guidelines of choice of projection for X-ray examinations to reduce patients' exposure

I. P. Matthews and D. Yates
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An observational study of radiographic practice carried out from 1983-86 throughout Wales has revealed a wide interdepartmental variation in patients' exposure for the same type of examination. The variations in the number of projections and their associated film sizes for a particular type of examination have been shown to be a significant determinant in this variation. Currently, a multicentre evaluation of implementation of guidelines of choice of projection relating to 11 frequently performed procedures is revealing useful information with regard to (a) the compliance with the guidelines; (b) acceptability of the guidelines to radiologists and radiographers (*e.g.* ensuring that guidelines result in adequate information); (c)clinical exceptions to the guidelines (additional to those already specified). These guidelines, if successfully implemented, would have important implications for prevention of radiogenic cancers attributable to current use of diagnostic radiology in the UK. In the light of the results of this evaluation, the prospects of implementing guidelines nationally will be discussed.

Quality assurance in PACS

R. M. Dawood, J. O. M. C. Craig, J. H. Highman, A. Todd-Pokropek and A. W. Porter
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Current methods of quality assurance (QA) have taken years to develop and refine. Though sometimes regarded as a tedious chore, QA remains an inescapable necessity for every modern film-based X-ray department that aspires to provide a good service. The arrival of new digital technology brings new and unfamiliar problems of QA that have so far received little attention, but that have important practical consequences for the day-to-day viability of such systems. We have examined the problems of setting up and monitoring the performance of TV display systems — for physical parameters such as phosphor characteristics, flicker, jitter, spatial and contrast resolution, temporal uniformity, spatial uniformity, spatial distortion, signal-to-noise ratio, dynamic range and interference from other equipment. We have also had to monitor the performance of film digitizers. Computed radiography produces images of consistent appearance over a much wider exposure range than conventional film: QA provision for such systems must include patient dosimetry. QA is the responsibility of individual departments, and will inevitably remain so. With as many as 30–40 UK centres currently examining the prospects for introducing PACS, it is important that the need for adequate QA should be recognized and allowed for.

Design and performance of a computerized quality assurance and patient dosimetry system in diagnostic radiology

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A system has been developed to undertake automatic quality assurance and dosimetry for diagnostic radiology examinations. A microcomputer has been interfaced to a microprocessor-controlled generator, and this allows tube and generator parameters to be measured for each exposure, and compared to nominal settings. Patient and examination details are entered by the operator, and exposure-area product and field size are automatically monitored for each radiographic exposure. The data collected, together with data already stored in the computer memory, are used to calculate the energy imparted to the patient, and individual organ doses. A laboratory study has been undertaken to investigate the accuracy and reproducibility of the measurements and calculations made by the automated system. Concurrent measurements of quality assurance parameters were made using standard techniques, and doses were measured using a RANDO anthropomorphic phantom and thermoluminescent dosimeters. The results of the study show that the automated system can measure exposure parameters with accuracy comparable to that of standard techniques, and that it is suitable for performing on-line dosimetry.

The effect of shielding trays on surface absorbed dose outside primary megavoltage radiotherapy beams.

A. Morgan
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Shielding trays are commonly used in radiotherapy. Their purpose is to hold lead blocks within the primary radiation beam in order to reduce the dose to specified normal tissues. However, the presence of a shielding tray produces scattered radiation which significantly increases the surface dose outside the primary beam, relative to an unleaded field. Surface doses of 14% of the dose maximum on the central axis of the beam have been recorded 5 cm outside the primary beam with a shielding tray in position. A series of measurements has been performed on various Perspex shielding trays used in this centre to determine (1) the magnitude of the effect and its variation with field size; (2) the quality of the scattered radiation; (3) the variation of (1) and (2) with primary beam energy. Results of the above measurements are presented and methods of reducing the amount of scatter by suitable lead tray design and local patient shielding are discussed.

The diary of a "rogue" mobile breast screening unit: a chronological QC record of its eventual demise, aged 19 months

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A mobile breast screening unit without on-board processing was delivered and commissioned in May 1988, after some minor faults had been satisfactorily rectified by the manufacturers. Problems in the operation of the AEC soon became apparent. During clinical use, these included poor repeatability, poor reproducibility, premature termination of exposure and refusal to expose. These were attributable to unstable environmental conditions and poor AEC design. They occasionally resulted in daily variations in density of –0.56 D (maximum) and variations during the day of +0.49 D (maximum) and also adversely affected reject rates. Results are presented to illustrate the nature and progression of the problems, the staff's corrective action and the manufacturers' response. The problems helped to test all aspects of the QA programme from the performance of simple QC tests to the data records and the necessity of good management, communication and physics support. The results also indicate that good QA cannot compensate for poor inherent performance. The unit was finally replaced in January 1990 by the manufacturers, having screened approximately 10600 women in 19 months.

A study of patient dosage and protection in computed tomography. 1. Patient dosage, distributions and hygienic evaluation during chest CT scanning.

D-Y. Qi, *D-H. Feng and *S-J. Li
*Department of Public Health, The Third Military Medical University, Chongqing, and *Department of Radiation Medicine, Suzhou Medical College, Suzhou, People's Republic of China*

In large X-ray departments, whole-body computed tomography is now the rule rather than the exception and more uses are being found for the particular way it can record anatomical structures. A knowledge of the patient dose, and the dose distribution during different investigations, is very important and essential in minimizing patient dose, ensuring that sensitive areas are not over-exposed and estimating the patient risk. Chest CT scanning was 18.2% of torso scanning in all of CT-examined 5776 patients in the Suzhou area in 1987. Fifteen patient dosages were measured using LiF thermoluminescent dosemeters in Hitachi CT-W500 scanning under perfect clinical conditions. The mean surface exposure in direct view of the beam was 2.98 R. Distributions of patient surface dose have been studied. The patient main organ/tissue absorbed dose and the effective dose equivalent during average 20-slice CT chest scanning have been obtained by use of the phantom simulation irradiation experiments (Table). CT chest scanning was compared with regular radiographic chest examinations from the saftey aspect.

Organ/tissue absorbed dose and effective dose equivalent in chest scanning

Organ/ tissue	W_T		Average surface exposure (R)	Absorbed dose (mGy)	Effective dose equivalent (mSv)
	M	F			
Thyroid	0.04	0.03	0.1643	1.0357	
Breast	—	0.26	2.9792	24.528	
Lung	0.14	0.10	2.9792	23.175	
Ovary	—	0.21	0.0400	0.3590	M: 6.4857
Testes	0.29	—	0.0180	0.1512	F: 11.468
Bone marrow	0.18	0.13	—	6.4704	
Other	0.35	0.27	—	5.6878	

A study of patient dosage and protection in computed tomography. 2. Patient dosage, distributions and hygienic evaluation during liver CT scanning

D-Y. Qi, *S-J. Li and *D-H. Feng
*Department of Public Health, The Third Military Medical University, Chonqing, and *Department of Radiation Medicine, Suzhou Medical College, Suzhou, People's Republic of China*

In all the 5776 patients in the Suzhou area examined by CT in 1987, the most frequently scanned organ of the body was the liver (41.9%), but specific studies on the patient dose are still very rare. Twelve patient dosages were measured using LiF thermoluminescent dosemeters in Hitachi CT-W500 scanning under perfect clinical conditions. The mean surface exposure in direct view of the beam was 2.6 R. Distributions of patient surface dose have been studied by fitting scattered radiation distribution curve equations. The patient main organ/tissue absorbed dose and the effective dose equivalent during average 12-slice scanning have been achieved using the phantom simulation irradiation experiments. The safety was also evaluated.

Organ/tissue absorbed dose and effective dose equivalent in liver CT scanning

Organ/ tissue	W_T		Average surface exposure (R)	Absorbed dose (mGy)	Effective dose equivalent (mSv)
	M	F			
Thyroid	0.04	0.03	0.0236	0.1488	
Breast	—	0.26	0.2627	2.1628	
Lung	0.14	0.10	0.5768	4.4869	
Ovary	—	0.21	0.0821	0.7369	M: 4.7795
Testes	0.29	—	0.0137	0.1159	F: 4.3079
Bone marrow	0.18	0.13	—	3.8749	
Other	0.35	0.27	—	9.7552	

A study of patient dosage and protection in computed tomography. 3. Patient dosage, distributions and safety evaluation during lumbar vertebra CT scanning

D-Y. Qi, *S-J. Li and *D-H. Feng
*Department of Public Health, The Third Military Medical University, Chongqing, and *Department of Radiation Medicine, Suzhou Medical College, Suzhou, People's Republic of China*

Lumbar vertebra CT scanning comprised 22.6% of body CT examinations in all of the 5776 patients in Suzhou examined by CT in 1987, especially with greater mA, longer scanning time and younger patients than in the other CT examinations, but the specific studies on the patient dose are still very rare. A method for standardized patient dosage measurement in Hitachi CT-W500 lumbar vertebra scanning under perfect clinical conditions has been established. The mean surface exposure in direct view of the beam was 5.75 R. Distributions of patient surface scattered dose have been studied by fitting curve equations. The patient main organ/tissue absorbed dose and the effective dose equivalent during average 7-slice scanning have been achieved using the phantom simulation experiments. Some further suggestions have been given.

Organ/tissue absorbed dose and effective dose equivalent in lumbar vertebra CT scanning

Organ/ tissue	W_T		Average surface exposure (R)	Absorbed dose (mGy)	Effective dose equivalent (mSv)
	M	F			
Thyroid	0.04	0.03	—	—	
Breast	—	0.26	0.0281	0.2313	
Lung	0.14	0.10	0.0234	0.1820	
Ovary	—	0.21	0.4616	4.1433	M: 1.2286
Testes	0.29	—	0.1002	0.8418	F: 1.6656
Bone marrow	0.18	0.13	—	2.5540	
Other	0.35	0.27		1.4266	

Charter Suite

The Role of Radiology in Surveillance Policies for Testicular Tumours (9.00–12.00)

Organizer: Dr M. P. Williams, Plymouth
Chairman: Dr A. K. Dixon, Cambridge
Panel: A. Horwich, Sutton; R. J. Johnson, Manchester; G. Rustin, London; M. P. Williams, Plymouth

Surveillance policies for testicular tumours

M. P. Williams
Department of Radiology, Freedom Fields Hospital, Plymouth PL4 7JJ

In order to run a surveillance policy it is essential to understand the pattern and time scale of metastases from testicular tumours and the strengths and weakness of the techniques to be employed. A review of 147 patients with non-seminomatous germ cell tumours of the testis on surveillance showed relapse in 37 (25%). CT scanning demonstrated relapse in 28, serum markers in 25, chest radiographs in eight, lymphography follow-up in five and marker relapse only in eight. No patient had a diagnosis of relapse based solely on lymphography and only one patient had a positive lymphangiogram with a negative abdominal CT scan. When the study was extended for a further 12 months, 47 out of a total of 168 patients relapsed, 83% in the first year, 9% in the second year, 6% in the third and 1% in the fourth. Maximum surveillance effort must be made in the first 12 months on patients with non-seminomatous germ cell tumours. All patients with abdominal relapses had involved nodes between the level of the renal hala and the aortic bifurcation. Scanning techniques should thus pay most attention to this area. In this study, employing CT at 2–3 monthly intervals during the first year, over 90% of the relapses detected fell within the Medical Research Council "good prognosis" group.

Surveillance policies for testicular tumours

A. Horwich
Radiotherapy Unit, The Royal Marsden Hospital, Downs Road, Sutton, Surrey SM2 5PT

With the development of effective chemotherapy for metastatic disease it has become practicable to consider surveillance for Stage I testicular tumours to replace routine adjuvant therapy. At the Royal Marsden Hospital, surveillance of Stage I non-seminoma was initiated in 1979 and more than 200 patients have now been followed up. Approximately 26% of patients have subclinical metastases at the time of their initial staging and that pattern of relapse is very predominantly within the first 2 years after orchidectomy. Furthermore, detailed examination of the histology of the primary tumour indicated groups at higher or lower risk of recurrence. Subsequently, the management policy of surveillance has been analysed in a multicentre setting. The Medical Research Council Testicular Tumour Working Party performed a 10-centre retrospective analysis of surveillance in 259 patients (Freedman et al, 1987). This confirmed the safety of surveillance since only three patients died of progressive teratoma; 28% relapsed and again histology was useful in determining the risk of recurrence. The important histological features discerned on multivariate analyses were vascular invasion, lymphatic invasion, undifferentiated cells and absence of yolk sac elements. If three or four of these factors were present, then the risk of recurrence was 58%.

This prognostic index was tested in a prospective surveillance study, was validated and has now provided a basis for studying adjuvant chemotherapy in patients with a high risk of recurrence while the remainder may be candidates for less intensive surveillance. In Stage I testicular non-seminoma, surveillance therefore provides an excellent alternative to either adjuvant retroperitoneal irradiation or to retroperitoneal lymphadenectomy. Since all early stage patients have an excellent overall prognosis, the important issue on which management decisions are based, is the morbidity of treatment alternatives. Surveillance minimizes specific anticancer treatments in that 70% of patients need no treatment following orchidectomy; however, surveillance must be conducted rigorously as an active policy rather than by clinical neglect. The policy must be designed to detect recurrences at an early stage when chemotherapy can be both curative and of low toxicity. This is aided by the sensitivity of current radiological techniques but also by the presence of sensitive and specific serum tumour markers. Research on surveillance should define the optimal programme to ensure clinical safety and economic use of resources. Surveillance in Stage I seminoma has been explored on a much more limited scale. The rationale for this investigation is the avoidance of the side effects of the standard management of Stage I seminoma, namely retroperitoneal irradiation: acute nausea/vomiting, a low risk of peptic ulceration and possible risk of late malignancy. The surveillance policy differs from that in Stage I non-seminoma because of the indolent course of the disease and because of the absence of a sensitive serum tumour marker. The RMH surveillance policy includes initial lymphography and CT scanning of thorax and abdomen. Follow-up includes both postero-anterior and oblique abdominal films for as long as lymphographic contrast media remains, and is continued for 5 years post-orchidectomy with abdominal CT scan each year. Of 113 patients registered on surveillance at the RMH between 1983 and 1988, the median follow-up is 33 months and the actuarial probability of remaining relapse-free at 3 years is 85%. Relapses have been seen up to 3 years, and relatively few patients have been followed for more than 4 years. Relapses are mainly in para-aortic nodes (14/15 recurrences). Two of these patients developed masses more than 5 cm in diameter before recurrence was discovered. Four patients have developed second relapses in the mediastinum and these may represent a consequence of delayed treatment of abdominal disease. The policy appears safe in that no patient has died of seminoma and all patients are currently in remission. However, surveillance in Stage I seminoma is labour-intensive and stressful both for clinician and patient, and in view of the excellent results of radiotherapy, it is felt that surveillance should only be continued in a research setting pending further evaluation.

Reference

FREEDMAN et al (for MRC Testicular Tumour Working Party), 1987. *Lancet, ii*, 294–297.

Teach-in: Radiotherapy Planning for Head and Neck Cancers (2.30–3.45)

D. V. Ash
Cookridge Hospital, Leeds LS16 6QB

Abstract not received.

Congress Theatre

MacKenzie Davidson Memorial Lecture (12.15–1.15)

Interventional Ultrasound

H. H. Holm
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Since ultrasound scanning is the most convenient, rapid and precise method to guide a puncture needle, interventional ultrasound plays an increasingly important role in the management of more and more patients. "Material" in its broadest sense can be removed from the body or deposited into the body for diagnostic as well as for therapeutic reasons. The result is a large and increasing number of applications of which the most important and newest will be reviewed. The various ultrasonically guided biopsy techniques are described as well as some of their abdominal and extra-abdominal applications. Ultrasonically-guided access to tubular structures such as antegrade pyelography, PTC, pancreatography and central venous catheter placement are mentioned. Placement of nephrostomy catheters and treatment of abdominal and extra-abdominal abscesses as well as pancreatic pseudocysts are described. Various methods for ultrasonically guided tissue destruction (*e.g.* of prostatic cancer, liver tumours, parathyroid adenomas and coeliac plexus block) are presented. They include, for example, alcohol, radioactive seeds and Nd-YAG laser hyperthermia. The risk of interventional ultrasound is discussed. It is concluded that interventional ultrasound is an extremely valuable diagnostic and therapeutic tool which spares many patients much more traumatic procedures, that patient management today in many cases rests on a more firm basis than prior to the introduction of interventional ultrasound, that the future undoubtedly will bring many new applications of the technique, and that, like most other procedures, it carries a risk which, however, is remarkably low.

Notes

Tuesday 12 June

Harewood Suite

Liver and Biliary System (9.00–10.15)

Radiology of the liver

A. L. Baert and G. Marchal
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During the last decade the number of imaging modalities for the study of liver disease has been constantly growing: nuclear medicine, angiography, US, CT and more recently MRI have become part of the diagnostic modalities available in most large hospitals. *Focal liver lesions:* ultrasound has proved highly sensitive for detecting focal liver lesions, but will only rarely allow differential diagnosis. The value of CT in the detection of small lesions (1 cm or less) is hampered by technical factors such as the level of breath-holding and slice thickness. CECT performed during the portal phase after superior mesenteric artery injection is however actually the most sensitive method for detection of metastatic liver disease. The detection rate of focal liver lesions at high field strength MRI is equal or superior to CT. The results can be improved by IV superparamagnetic iron oxide (ferrite) injection. An MRI differential diagnosis of liver tumours is mainly based on signal intensity but also on morphological features. Large comparative studies are however still needed to assess the value of MRI in this regard as compared with CECT. Ultrasound and MRI are particularly helpful in defining hepatic anatomy prior to surgery because of the excellent visualization of the hepatic veins and the possibility of multiplanar imaging. $^{99}Tc^{m}$ labelled red blood cell studies are successful in differentiating haemangioma from other focal liver lesions. If surgical treatment of focal liver lesions is considered, angiography is still necessary for precise demonstration of arterial anatomy. On the contrary, intra-arterial injection of oily iodine contrast medium (lipiodol) is not accurate in the detection of secondary tumours in patients with hepatocellular carcinoma, as it accumulates in cavernous haemangioma. Frequently, the combined intra-arterial administration of lipiodol and chemotherapeutic agents is tested in some centres but its efficiency remains to be proven. *Diffuse parenchymal disease:* ultrasound and CT are both well suited for the diagnosis of diffuse or focal hepatic steatosis or changes produced by hepatitis and cirrhosis. Haemochromatosis can be proven both by CT and MRI. Both haemochromatosis and steatosis are however best qualified by CT. The correct choice and appropriate use of these techniques should not only consider sensitivity and specificity but also cost, accessibility, invasiveness and last but not least therapeutic consequences.

Dynamic contrast enhanced CT scanning in prognostically severe acute pancreatitis

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*Departments of Radiology, *Surgery and †Pathology, Leicester Royal Infirmary, Leicester LE1 5WW*

Bolus contrast-enhanced CT demonstrates areas of non-enhancement in the pancreas which are postulated to represent necrosis. Early surgery in infected necrosis is reported to reduce mortality. In a prospective trial we perform dynamic contrast-enhanced scans on patients predicted severe by biochemical criteria (three or more adverse Glasgow criteria), or having CRP on Day 3 > 0.15 g/l or a WCC>15 x 10^9 on Day 7. CT-guided fine needle aspiration is performed on non-enhancing areas for cytological and bacteriological examination. To date 43 patients have been scanned and our findings are: (1) these selection criteria are useful, all patients with a severe outcome qualified for a scan; (2) cytology revealed amorphous debris compatible with necrosis; (3) the extent of CT necrosis is not always related to severity; some cases with extensive necrosis recovered early; (4) in three cases pseudocysts developed at the site of necrosis; (5) repeat scans at 6 weeks show persisting non-enhancement and in one case ERP demonstrated cut-off of the pancreatic duct at the junction between normally enhancing and necrotic pancreas; (6) infected necrosis in our experience is uniformly fatal and this group of patients is more likely to benefit from early surgery.

Corrugation of the common duct during endoscopic retrograde choledochopancreatography: a sensitive but non-specific indicator of pancreatico-biliary disease

P. M. Hughes, D. F. Martin and H. J. Fairhurst
Department of Diagnostic Radiology, University Hospital of South Manchester, Nell Lane, Manchester M20

Review of 435 endoscopic retrograde choledochopancreatograms (ERCP) has identified a group of 54 patients demonstrating a feature we have termed corrugation. The ERCPs were evaluated to determine the degree of common duct filling, the presence of pathological abnormality, the extent of corrugation and its persistence on repeat examination in order to determine its sensitivity and specificity as a diagnostic sign. Fifty (93%) of the ERCPs with evidence of corrugation demonstrated biliary or pancreatic abnormality. Common duct stones were identified in 36 cases, pancreatic or cholangiocarcinomas in 12, while one demonstrated an impacted stone in Hartmann's pouch and another a dilated common duct and periampullary diverticulum. The four remaining cases with corrugation but no radiological abnormality at ERCP had biochemical and ultrasonic evidence of acute pancreatitis. Of 16 repeat ERCPs, 15 again showed corrugation. While accepting that ERCP examinations are performed on a selective population, common duct corrugation — a sign not previously described to the authors' knowledge — appears a sensitive but non-specific indicator of pancreatico-biliary disease.

Comparison of cholescintigraphy, ultrasound and ERCP in 55 patients with intrahepatic cholelithiasis

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Intrahepatic cholelithiasis causes duct dilation, stricture formation and hepatic parenchymal atrophy. Patients frequently present with acute cholangitis. The aim of this study was to compare the additional functional information provided by cholescintigraphy with the morphological information provided by ultrasound and ERCP. Fifty-five patients had cholescintigraphy (1.85 MBq (5 mCi) EHIDA), ultrasound and ERCP on admission. Nasobiliary drains were inserted at ERCP when indicated. Analysis of the five phases of cholescintigraphy (perfusion, hepatocyte, excretion, CBD/small bowel and gall bladder) provided significant additional information regarding the presence of intrahepatic cholelithiasis, duct dilatation, abscess formation and parenchymal hypofunction, not available from ultrasonic or endoscopic examination. The addition of cholescintigraphy materially benefits the management of the acute and chronic phases of intrahepatic cholelithiasis.

Correlation of staging with survival in patients with cholangiocarcinoma

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Cholangiocarcinoma is rare and carries a poor prognosis. Knowledge of the distribution of the tumour is essential to successful treatment either by palliative stenting or surgery. In a prospective study 31 patients with an ultrasound diagnosis of cholangiocarcinoma underwent endoscopic retrograde cholangiopancreatography (ERCP). Diagnosis was confirmed by clinical follow-up. The tumour was extrahepatic in 12 cases (39%) and situated at the hilum in 19 (61%). The maximum tumour dimension varied from 10 mm to 89 mm with a mean of 38 mm. Of the tumours, 58% had irregular margins and 71% were homogenous in echo pattern. The tumour echogenicity was less than that of the liver in 42%, equal in 42% and increased in 16%. Doppler signals were detected in the tumour in only four patients and there was evidence of portal vein involvement in five cases. Regional lymphadenopathy was seen in 58% and liver metastases in 10%. The ERCP findings agreed precisely with ultrasonography in 56% of cases and estimated greater tumour extent in 22%. In two patients the final diagnosis was gallstones. There were four ERCP failures. Ultrasonography is an accurate diagnostic method which maps the biliary tree and provides information on tumour load, important in planning treatment. The relation of these factors to survival is discussed.

Diagnostic value of cholangiograms in patients with obstructive jaundice

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The cholangiograms (PTC and ERCP) of 147 patients with surgical obstructive jaundice, who had a final diagnosis based on operative findings, biopsy, autopsy or endoscopy, were evaluated to assess their diagnostic value in different surgical conditions; and the liver-function tests were then correlated. The sensitivity and specificity of the cholangiograms in differentiating between benign and

malignant conditions were 84% and 86% respectively; 86% and 93% for the diagnosis of choledocholithiasis, and 48% and 71% for the diagnosis of benign non-calculous conditions. A significantly higher value of the total serum bilirubin level and a larger transverse diameter of the gallbladder (GB) were recorded in patients with malignant obstruction. However, there were no statistically significant differences between the groups regarding the maximum diameters of the intrahepatic ducts (IHD), common hepatic duct (CHD) and common bile duct (CBD), nor in terms of the serum alkaline phosphatase concentration. The study concludes that: (1) direct cholangiography still plays an important role in diagnosis of different surgical conditions; (2) the diameters of the IHD, CHD, CBD and GB alone (*e.g.* measured by ultrasound) cannot reliably differentiate benign and malignant conditions; however, small shrunken GB makes diagnosis of a malignant obstruction very unlikely; and finally, (3) in the absence of a history of biliary surgery or the usual cholangiographic features of calculous obstruction, any complete or near-complete obstruction in the biliary system must be highly suspicious for malignant condition regardless of the cholangiographic appearances.

A strategy for percutaneous removal of multiple intrahepatic calculi

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The removal of multiple intrahepatic biliary calculi can present formidable problems especially following hepaticojejunostomy. We have treated eight patients with this condition, six of whom had benign hepaticojejunostomy strictures and two retained calculi following cholecystectomy. In patients with strictures a Roux loop was fixed subcutaneously at the time of surgery and marked with metallic clips. It was used later by the radiologist for retrograde access to the biliary tree. A combination of saline irrigation, Dormia-type baskets and occlusion balloons was used to clear the biliary tree of calculi. Occlusion balloons proved particularly useful in dealing with small calculi in distal ducts. The strictures were dilated and in two cases Gianturco self-expandable metallic stents were inserted. In five patients all of the calculi were successfully retrieved. In the remaining three complete removal was not possible but subsequent clinical management was made much easier following radiological intervention. There were three cases of post-procedure cholangitis. The patients have remained symptom-free for a median period of 16 months (mean 12.4 months). Two patients developed recurrent stones after 27 months and 6 months respectively and were successfully treated again. The strategy described appears successful in dealing with the majority of complex patients with intrahepatic calculi.

Percutaneous cholecystostomy in the treatment of acute calculous cholecystitis in high-risk patients

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Surgical cholecystostomy is regarded as the safest operative method for the treatment of acute cholecystitis, with an operative mortality of 0.5%. However, in the emergency situation and in high-risk patients, the mortality rate can rise as high as 15%. Percutaneous cholecystostomy (PC), when performed in patients undergoing lithotripsy or dissolution therapy or as part of percutaneous stone extraction in the treatment of gallstones, is a difficult procedure and requires both skill and experience. However, when PC is performed in patients with either calculous or acalculous cholecystitis, it is a relatively simple and safe procedure which is performed under local anaesthetic. Whereas PC is now the accepted treatment in acalculous cholecystitis, it has not gained widespread approval in the treatment of calculous cholecystitis, not even in high-risk patients. We present three elderly patients with calculous cholecystitis who failed to settle on conservative treatment; two were considered high-risk and one refused surgery initially. All three patients had PCs with immediate relief of pain with rapid resolution of all symptoms and signs. Two had elective cholecystectomies 3 and 7 months after the PC. The third patient refused surgery and has remained asymptomatic for 1 year. PC is simple and safe and can be life-saving and should be considered as an alternative method of treatment in the management of acute calculous cholecystitis, in particular in elderly and high-risk patients. Elective surgery in these groups of patients should only be offered to those who remain symptomatic.

Benign biliary disease: percutaneous endoprosthesis or balloon dilatation?

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When surgery is not considered appropriate, and when an endoscopic approach is not possible, patients with symptomatic benign biliary strictures provide a therapeutic dilemma. We have treated 21 such patients, (11 female, 10 male) with a mean age of 55 years (range 23–78), with either percutaneous insertion of an endoprosthesis (PE) or percutaneous balloon dilatation (PD). Twenty patients had postoperative strictures and of these 16 followed cholecystectomy. One patient had primary sclerosing cholangitis. In 17 of the patients a total of 32 corrective biliary operations had been performed. The indication for the percutaneous procedure was recurrent cholangitis with or without janudice. The mean bilirubin before the procedure was 76 μmol/l [range 5–576 (normal < 17 μmol/l)]. Ten patients had PD, 11 PE (six Teflon endoprostheses and five metal). Four patients in each group developed early complications (*i.e.* less than 24 h after the procedure). The median asymptomatic period following the procedure was PD 11.5 months (range 3–43), PE 11 months (range 5–96). A further procedure (or surgery) for recurrent symptoms was necessary in PD 5/10 and PE 4/11 at a median of 12 and 14 months respectively. All five PD patients who have not required further intervention are asymptomatic at median follow-up of 14 months. Patients in both groups achieved a valuable period of biliary drainage. However 43% needed a further procedure 3 months to 5 years later. Despite recent advances, these data do not suggest that PD is better than or worse than PE

Technical aspects of percutaneous gallstone dissolution with methyl-tert-butyl-ether (MTBE)

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Cholesterol gallstones in a functioning gallbladder can be treated by percutaneous cholecystostomy and infusion of MTBE. We report on our initial experience in 14 patients, emphasizing technical aspects of catheter placement and manipulation during MTBE dissolution. Difficulties in catheterization were related to insufficient analgesia, resistance of the gallbladder wall, gallbladder mobility and invagination of the gallbladder wall. Failure in catheterization was associated with intro-peritoneal biliary leakage. Semi-urgent cholecystectomy in two patients resulted and elective cholecystectomy in a third. A further problem that we encountered was extrusion of the pigtail catheter, during MTBE infusion, as a result of respiratory movement (two patients). This was overcome by using a longer (70 cm) catheter and coiling it in the gallbladder. Maximal stone dissolution occurs within the pigtail of the catheter where MTBE concentration is greatest. Manipulation of the catheter during dissolution is therefore desirable to ensure that stones remain in an optimal position. We found that various refinements of technique were required during the initial learning period before technical success could be reliably achieved.

Notes

Chest Radiology (10.45–12.00)

Diagnosis of pulmonary embolism

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The diagnosis of pulmonary embolism remains a widespread problem. Both clinical assessment and the chest radiograph are inaccurate and therefore the patients undergoing further investigation represent a small proportion of the real incidence in a hospital population. Ventilation perfusion imaging has a high accuracy where the perfusion defects are large or multiple, but where they are sub-segmental, correlation with positive angiography falls to non-diagnostic levels, probably due to poor resolution for both sets of images. An alternative approach is the identification of patients at risk by localizing venous thrombus by ultrasound or radioactive tracer. Prospective imaging of venous thrombus in post-operative patients can be performed using a radiolabelled monoclonal antibody with high affinity for platelets (Greenspan et al, 1982; Lavender et al, 1988). This tracer can be used to look at the natural history of post-operative thrombus and also allows imaging of the clot in the pulmonary artery. Data based on 30 post-operative patients imaged in this way showed a greater than 50% incidence of thrombus, mainly in calf veins, with a 20% incidence of pulmonary emboli most of which could be visualized with this tracer. Direct methods of identifying both peripheral and central thrombus seem to offer the way forward in dealing with the widespread clinical problem of thromboembolic disease.

References

GREENSPAN R.H., RAVIN, C. E., POLANSKY, S. M. & MCCOUD, T. C., 1982. Accuracy of the chest radiograph in diagnosis of pulmonary embolism. *Investigative Radiology, 17,* 539–543.

LAVENDER J. P., STUTTLE, A. W. J., PETERS, A. M., O'DONNELL, C. J., DAVIES, G. J., HARRISON, R. & HOGG, N., 1988. *In vivo* studies with an anti-platelet monoclonal antibody; P256. *Nuclear Medicine Communications, 9,* 817–822.

STUTTLE A. W. J., KLOSOK, J., PETERS, A. M. & LAVENDER, J. P., 1989. Sequential imaging of post-operative thrombus In-III-labelled platelet-specific monoclonal antibody P256. *British Journal of Radiology, 62,* 963–969.

Magnetic Resonance anatomical and flow imaging of pulmonary arteries in patients with single lung transplantation

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Magnetic resonance imaging has been used to study pulmonary arterial anatomy and to measure pulmonary arterial blood flow in patients with single lung transplantation. Nine patients and nine controls matched for age and sex were studied. The anatomy of the main pulmonary artery and its main branches, as well as the site of arterial anastomoses, were identified and their diameters measured. There were no significant differences in diameters of these vessels between the patients and their controls. Arterial blood flows to the transplanted lung were 2.07±0.45 l/min/m^2 in the group with right side transplantation and 2.43±0.60 l/min/m^2 in the left sided group compared with (1.22±0.22) l/min/m^2 and (1.27 ±0.41) l/min/m^2 in the control group respectively. The ratio of blood flow in the transplanted and the native lungs in all patients studied was 2.8±0.83 : 1. The flow profile in the artery of the transplanted lung shows a wide forward flow during systole and most of diastole, while that of the native lung shows a narrow early systolic peak and a reverse flow in most of diastole. This differential flow and its pattern are most likely to be related to the relative resistance in the native and transplanted lung and could well be a good index for monitoring and follow-up of patients with lung transplantation.

Pulmonary Kaposi's sarcoma; a review of the radiographic appearances in the St Mary's Hospital group of patients with the Acquired Immune Deficiency Syndrome

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In patients with the Acquired Immune Deficiency Syndrome (AIDS), Kaposi's sarcoma causes significant morbidity and mortality. Although skin involvement is the most common manifestation, the disease is systemic, particularly affecting the lungs and gastrointestinal tract. Lung involvement should be suspected when the chest radiograph demonstrates nodular infiltrates, pleural effusions or lymphadenopathy. In some cases, consolidation repeatedly occurs in a particular segment due to a partially obstructing endobronchial lesion. Of 360 AIDS patients seen at St Mary's, 29 have had bronchoscopically proven Kaposi's sarcoma. We present the radiographic appearances in this group.

CT and ultrasound-guided drainage of pleural empyemas and malignant effusion using fine pigtail catheters

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Drainage of pleural collections is usually performed using Argyle chest drains or repeated aspirations. We describe a series of 34 cases (26 empyemas and seven malignant effusions) in which the collections were drained by CT or ultrasound insertion of a pigtail catheter. A 7 F catheter was used in adults and a 5 F or 6 F one in children. Drainage was by a closed system into a plastic drainage bag and thick collections of pus were irrigated with normal saline. Three cases of multiloculated empyema were treated by the simultaneous insertion of two catheters. In only one case (malignant effusion) was catheter replacement necessary because it became blocked. Three empyema cases which were slow to resolve were managed as outpatients. In one of these a broncho-pleural fistula which required surgical treatment was later demonstrated. Two other cases required surgery due to the persistence of the cavity. No complications of the procedure occurred and no infection developed at the catheter site. We conclude that radiologically-guided fine catheter drainage of pleural collections is a safe and effective method and that drainage by large chest drains or repeated aspirations is unnecessary.

Sensitivity of fine needle transthoracic percutaneous needle biopsy (TNAB) versus histological type, mass size and location of lung carcinoma

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Though TNAB is a well established method for obtaining malignant pathological confirmation of lung carcinoma, in the literature an overall non-diagnostic rate of 15–20% is quoted. To investigate possible negative influences on biopsy rate, we have analysed results of TNAB vs cell type, mass size and location in 129 patients with bronchogenic carcinoma. Overall, TNAB was successful in 89% of cases. Sensitivity was best for small-cell carcinomas (100%) where therapeutic implications are greatest in non-resectable disease, and it was least for squamous cell tumours (72%). Non-diagnostic aspirates occurred in seven of 60 masses over 3 cm in size and in three of 29 masses over 6 cm. Twenty-eight of 30 central tumours showed positive histology vs 77 of 89 peripheral lesions. The negative influence of these variables in our patients was less than figures quoted for trans-bronchial biopsy. We conclude that cell type, tumour site or size (when over 3 cm) do not represent major determinants of yield for TNAB. If low sensitivities are achieved with this technique, they result from other factors. These results are elaborated and discussed.

High-resolution computed tomographic appearances of lymphangioleiomyomatosis

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Lymphangioleiomyomatosis is a rare condition characterized histologically by proliferation of smooth muscle throughout the lung. The chest radiographs and CT scans of 10 patients with pathologically proven disease were compared. Correlation was also made with lung function tests when available. Chest radiography demonstrated lungs with normal to increased volume with a diffuse fine reticular pattern interspersed with cystic air spaces. CT revealed uniform replacement of the lung with cysts of varying size from 2–30 mm in diameter. The cysts were extremely thin-walled and were evenly distributed throughout all lobes with no central or peripheral predominance. The degree of cystic change in the lung parenchyma visible on CT was much greater than that visible on chest radiographs. In one case with a normal chest radiograph there were definite cystic changes on the concurrent CT scan. There was good correlation between the extent of parenchyma judged to be involved on CT scans and lung function tests. Lymphangioleiomyomatosis has a distinctive cystic appearance on CT. Although not unique, the CT morphology and uniform distribution of abnormality frequently permit differentiation from other cystic conditions of the lung.

Pulmonary involvement in systemic lupus erythematosus: evaluation with computed tomography

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High-resolution CT of the chest has an established role in the assessment and monitoring of diffuse diseases of the lung parenchyma. As yet there has been no description in the literature of the appearances of lung involvement in systemic lupus erythematosus (SLE) on high-resolution CT. In SLE the pleura, lung parenchyma, pulmonary vasculature and diaphragm may be involved. The resulting changes reflected on conventional chest radiography include recurrent pleural effusions, subsegmental collapse, areas of consolidation and shrinking lung syndrome. We have reviewed our patients with SLE who have had high-resolution CT of the thorax over the past six years. All patients fulfilled the criteria of the American Association of Rheumatologists in establishing the diagnosis. In over 80% of cases there was evidence of pleural disease, either pleural thickening or small pleural effusions. Linear, band-like opacities were the next most common abnormality. These tended to be both peripheral and basal in distribution. Another frequent manifestation was small areas of consolidation and poorly defined areas of increased parenchymal density, visible in up to 60% of patients. The pathological explanation for these appearances needs further clarification since it remains uncertain whether they represent areas of lupus pneumonitis, infarction due to vasculitis, or intercurrent infection.

CT density mapping in the assessment of pulmonary emphysema: a technical appraisal

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Many modern CT scanners have post-processing facilities which allow pixels within a selected density range to be highlighted. It has recently been suggested that using this technique to highlight regions of low CT density (–900H to –1000H) can accurately locate and quantitate areas of pulmonary emphysema ("lung density mapping"). This method was evaluated in 17 subjects who had no evidence of structural lung disease on full respiratory function testing. CT technique was standardized. In sections obtained at the level of the carina, mean CT density varied from –770H to –875H (overall mean –817H). The percentage cross-sectional area in the range –900H to –1000H varied from 0.6% to 58% (mean 15.3%). In two further groups of subjects the influence of CT slice thickness and intravenous contrast administration on the lung density map was evaluated. The use of narrower collimation led to a significant increase in mean cross-sectional area within the low density range ($p < 0.05$). The use of intravenous contrast medium led to a significant reduction in cross-sectional area within this range ($p < 0.01$). There is considerable variation in the lung density map of normal individuals. The method is also dependent on radiographic technique. The potential usefulness and limitations of CT lung density mapping in the assessment of lung disease are discussed.

Notes

MRI scanning of the thorax in patients with active lymphoma

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The magnetic resonance imaging (MRI) findings are presented of 27 patients with lymphoma affecting the thorax (20 Hodgkin's, 7 NHL). Scanning was undertaken using a Picker Vista 0.5T MRI Scanner. T_1-weighted spin–echo coronal and transverse scans with corresponding STIR (short tau inversion recovery) scans were the most commonly employed sequences and proved efficacious in demonstrating pathology in the chest and mediastinum. Sagittal scans were useful for the thoracic spine. Abnormalities were shown in the mediastinum (15), perocardium (7), chest wall (5), pleura (4) and bone marrow (11). MRI was able to demonstrate mediastinal nodes, invasion of vascular structures and bone marrow involvement when not visible by CT. More surprisingly, MRI was also able to clearly show intrapulmonary nodules. MRI will have an important role in the staging and follow-up of patients with lymphoma.

TUESDAY

Thoracic computed tomography: value in respiratory failure secondary to kyphoscoliosis

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The chest radiographs of patients with a kyphoscoliosis severe enough to cause respiratory failure are often difficult to interpret because the spine and mediastinal structures overlie lung. In order to establish whether CT would be helpful in this situation, thoracic CT was performed prospectively on 10 patients. Informed consent was obtained from all. We confirmed that the plain chest radiograph is a particularly insensitive investigation in such patients, and was potentially misleading in several. Relatively gross pathology, such as right lower lobe collapse, was not visible on the chest radiograph, even in retrospect. Pulmonary artery size was also difficult to assess on the chest radiographs of several patients. In no patient did the abnormal thoracic structure prevent entry into the gantry nor scanning. CT was able to confirm or exclude pulmonary consolidation in patients with an acute exacerbation of their respiratory failure. CT was also able to determine pulmonary artery size. In conclusion, plain chest radiography can be misleading in patients with a severe thoracic kyphoscoliosis; CT is feasible, and can reveal gross pathology not visible on the chest radiograph.

Small Bowel Studies (2.50–3.45)

Plain radiographic and CT appearances of lesser sac hernias

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Internal hernias are rare, accounting for only 1% of all intraperitoneal causes of intestinal obstruction. Internal hernias through the lesser sac occur (in decreasing frequency) through the foramen of Winslow, the transverse mesocolon, the greater omentum and the lesser omentum. Foramen of Winslow hernias account for 8% of all internal hernias. Internal hernias through the gastro-hepatic omentum are extremely rare and to our knowledge only one case has been described. We have encountered three cases of lesser sac hernia, two via the foramen of Winslow and one via the gastro-hepatic omentum. Plain abdominal radiographs of all three cases are presented as well as the CT appearances of the gastro-hepatic omental hernia. We show that CT can differentiate between gastro-hepatic and foramen of Winslow hernias and that careful scrutiny of the CT and plain films can lead to a preoperative diagnosis.

Herniography in unexplained groin pain

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Sixty patients complaining of groin pain where no clinical abnormality was found were investigated using herniography, a simple outpatient procedure with a very low complication rate, in which non-ionic water-soluble contrast medium is injected directly into the peritoneal cavity using a 20-gauge needle. Radiographs are obtained in the prone, erect and oblique positions. The examination and interpretation of the radiographs are described. Herniography may detect hernial sacs not obvious clinically. Alternatively, the absence of hernial sac on herniography avoids needless groin exploratory surgery. The results and complication rates in the first 60 patients are described and the relationship between this investigation and the eventual clinical outcome detailed. A future role for herniography in the investigation of unexplained groin pain is discussed.

$^{99}Tc^{m}$-HMPAO imaging in Crohn's disease of the small bowel

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Radioisotope techniques using labelled leucocytes provide a relatively non-invasive means of determining the site and extent of disease activity in inflammatory bowel disorders, including Crohn's disease. Newer techniques use white cells labelled *in vitro* with 99m-technetiumhexamethyl propylene amine oxime (Tc-HMPAO)(Amersham). We report our initial experience using $^{99}Tc^{m}$-HMPAO-labelled leucocytes in 14 patients with known small bowel Crohn's disease. Eleven patients had comparable barium studies, *i.e.* performed within a year of the scan and with no intervening surgery. There was good correlation in nine as to the site and extent of disease. In one, the scan confirmed active disease when a small bowel enema suggested only deformity due to scarring. In a second, the technetium scan failed to show total colonic involvement demonstrated on barium studies. Of the remaining three patients, two were clinically well, one of whom had an abnormal scan. Perianal disease could not be visualized in the third. These early results show good correlation with barium studies and clinical evaluation and suggest this may be a useful and sensitive alternative method of imaging these patients.

Per-oral pneumocolon in the evaluation of the distal small bowel

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Although the small bowel enema is widely regarded as the 'gold standard' for examination of the small bowel, the small bowel meal (SBM) remains the most commonly performed procedure. The peroral pneumocolon examination (POPC) allows double-contrast images of the terminal ileum to be obtained by insufflating air through a rectal tube when orally ingested barium reaches the right colon. The technique

offers the possibility of improving the sensitivity of the standard SBM by (1) distending the distal small bowel, and (2) improving mucosal detail with double rather than single-contrast images. We have performed POPCs on 30 patients referred for SBMs. Standard views of the ileum were obtained before and after air insufflation. Blind comparison was made between the pre- and post-insufflation images, assessing maximum ileal distension, quality of the demonstration of the ileum, and degree of confidence of normality and abnormality. Air reflux was achieved in 23/30 cases (77%). Many patients found air insufflation uncomfortable, despite routine administration of intravenous glucagon. Although in most cases the distal ileum was better distended following insufflation, the certainty with which the observer felt pathology could be diagnosed or excluded was not significantly altered. In three patients who had previously undergone ileo-caecal resections for Crohn's disease, easy air reflux into the ileum occurred, allowing excellent demonstration of recurrent disease at the anastomosis. It is concluded that the POPC is not helpful as a routine technique for small bowel examination, but may be useful in patients who have had previous ileo-caecal resection.

TUESDAY

Hereditary pancreatitis: early ultrasound appearances

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Hereditary pancreatitis (HP) is a rare familial condition first described in 1952 which may present with acute abdominal pain in childhood. The radiological findings in a family with HP are presented. The radiological hallmark of HP is the extensive pancreatic calcification and the frequent and large pancreatic duct calculi. These have been reported as early as the second decade, more commonly in the third. The early ultrasound (US) features have not been previously described. The US appearances at acute presentation in a 2-year old boy and over a 3-year follow-up are shown. We demonstrate that progressive duct dilatation and other features of chronic pancreatitis can be appreciated on US in the absence of pancreatic calculi or calcification. The adult US features are illustrated. US is of value in the diagnosis and screening of family members as well as in following the clinical course and complications of affected individuals. The aetiology of HP remains unclear but early US appearances indicate that progressive pancreatic duct dilatation precedes the development of the characteristic pancreatic calculi and calcifications.

Right-sided diverticulitis

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Purely right-sided diverticulosis is rare in the West but accounts for approximately 68–76% of cases of diverticulosis in the Far East. Consequently right-sided diverticulitis is seen more commonly than in the West. We studied 604 consecutive barium enemas and the pathology, radiology and clinical details of the last 34 cases of diverticulitis, which are presented. None of the patients went to theatre with the correct diagnosis. All but one were considered to have appendicitis and the remaining patient, who had previously had an appendectomy, was thought to have a perforated caecum. Discriminating features that aid a successful pre-operative diagnosis of right-sided diverticulitis are: (1) a relatively longer history than appendicitis; (2) a relative lack of constitutional symptoms; (3) the age of the patient; (4) an awareness of the high frequency of right-sided diverticulosis in SE Asian patients.

Buscopan in radiological procedures — should patients drive afterwards?

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Buscopan (hyoscine-n-butyl bromide, HBB) is a smooth muscle relaxant regularly used in radiological and endoscopic procedures. One unwanted effect is temporary impairment of visual accommodation. Near and distance vision has been assessed in 100 patients undergoing barium meal and barium enema studies. Visual testing was performed prior to the examination and repeated immediately before leaving the X-ray department. Completed data were obtained in 90 patients. Of these, 37 were given a conventional 20 mg intravenous dose of HBB, 37 were given glucagon and 16 received no drug. No patient showed any impairment of distance vision. Minor abnormalities of near vision were observed in five patients, all of whom had been given HBB, were aged 50 years or under and had been re-tested 12–21 minutes after administration of the drug. It is suggested that the degree of visual impairment observed is not sufficient to impair driving ability and that patients need not be advised to delay their departure on this account. However, an explanation regarding possible changes in near vision is considered appropriate. The other ocular effects of HBB are also discussed.

Ripley Suite

Cardiac Studies (9.00–10.15)

Pharmacological stress in the diagnosis and management of coronary artery disease

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Some form of stress is essential to the functional assessment of coronary artery disease using non-invasive imaging techniques and dynamic exercise is widely used even though exercise tolerance may not be limited by cardiovascular symptoms. Pharmacological stress is an attractive alternative or adjunct, and dipyridamole has been used successfully with thallium-201 myocardial perfusion imaging despite the fact thats its method of action is poorly understood. It is a powerful coronary arterial dilator and defects of ^{201}Tl uptake occur because of the impaired flow reserve of diseased arteries which leads to a differential delivery to the territories served by diseased and by normal arteries. When given intravenously, it can also cause ischaemia, and possible mechanisms for ischaemia in the face of coronary dilatation include a pressure drop across a stenosis with high flow and a stealing of flow by arteries supplying collateral vessels. In order to investigate the relative importance of these mechanisms, we have compared ^{201}Tl emission tomograms acquired following intravenous dipyridamole with cine MR tomograms acquired under the same conditions in 40 patients with coronary artery disease. Defects of ^{201}Tl uptake were seen in all patients but new wall motion abnormalities were induced in only 60%, indicating true ischaemia in these patients. The patients with ischaemia had more extensive ^{201}Tl defects and more severe coronary artery disease, and were more likely to experience chest pain during the infusion. In a number of patients, alterations in MR signal were seen within the ischaemic myocardium and this is likely to represent alterations in blood content. Forty patients have also heen studied using intravenous dobutamine. This is also a coronary dilator, but is main action is to increase blood pressure, heart rate and contractility. Myocardial blood supply is therefore reduced and demand is increased. In all patients, both defects of ^{201}Tl uptake and of regional wall motion were observed. No adverse side effects were encountered other than chest pain, and most patients preferred the pharmacological stress to dynamic exercise. Dobutamine infusion therefore appears to be an ideal form of stress for MRI and the potential of MRI and spectroscopy in patients with coronary artery disease is obvious. The findings also throw new light upon the mechanism of action of dipyridamole when used during ^{201}Tl imaging.

Notes

Computer-assisted diagnosis of ischaemic heart disease: a system development and clinical trials for the interpretation of nuclear images

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Nuclear medicine procedures are applications of tracer technology to medicine, used for evaluation of tissue functions. Quantitative analysis and imaging of regional organ functions have been combined by the aid of computer systems since late 1960s. Image processing in nuclear medicine has been widely used in the study of heart diseases. In order to achieve efficient operation of routine nuclear medicine procedures, image processing computers in nuclear medicine were linked to the hospital information system (HIS). The third computer system was added, which is used for reporting the results of the studies and to construct a relational data base. Furthermore, artificial intelligence (AI) function was developed to support image interpretation and reporting. The system was applied to cardiac studies such as ^{201}Tl myocardial scintigraphy and ECG-gated cardiac blood pool scintigraphy (MUGA) for the diagnosis of ischaemic heart disease (IHS). The purpose of this presentation is to describe the whole scope of our computer-aided system for the diagnosis of IHS. The emphasis is put on the AI system for the interpretation of bull's eye display and MUGA. The bull's eye display of SPECT is transferred to the data base of the patient information management system (PM). When inference request is made, the feature extraction program extracts information on the extent, severity and localization of decreased count rates, comparing the data pixel by pixel with that obtained from seven normal controls. The inference engine is activated to determine the presence of focal defects, utilizing diagnostic rules in the knowledge base. The results are sent back to PM and reported, with the probability of assurance. Initial clinical trials on 58 patients revealed good agreement between nuclear physicians (NP) and AI. The system is useful, as it enables efficient implementation of nuclear medicine procedures and also provides NP with complementary and supportive information for interpreting and reporting nuclear medicine images.

MR measurement of cardiac output using cardiac-gated acquisition

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MRI can be used to provide quantitative velocity and flow information by using phase difference pulse sequences. We have applied a cardiac-gated flow-adjusted gradients (FLAG) pulse sequence to measure time-averaged flow in the ascending aorta and pulmonary artery of healthy volunteers. Data acquisition was performed on a 1.5T whole body system (Philips, Gyroscan). A minimum trigger delay of 8 ms was used for the first image with successive images obtained at 34 ms intervals. The number of images acquired was typically 17–20, which covered the systolic and most of the diastolic phase. The sequence used an rf flip angle of 45°, TE = 17 ms, a 256^2 data matrix and 1 signal average giving a scan time of 7-8 min. The images were analysed using a quantitative flow analysis program (Sun 3 Workstation). The region of interest was defined from the velocity-compensated modulus image and then used on the phase image for calculation of the area and average velocity. Each image yielded an instantaneous flow value. Flow values from the complete set of images were integrated to give the time-averaged flow. The results indicate that signal loss during the decelerative phase of systole leads to an underestimation of flow, particularly in the ascending aorta. This can be explained by both spatial and temporal averaging of the data due to voxel size and relatively long TE. The implications of the above for *in vivo* flow measurement using the cardiac-gated FLAG method are discussed.

Comparison of bull's eye polar maps and added circumferential profiles of detection of coronary artery disease using $^{99}Tc^{m}$ MIBI SPECT

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In the diagnosis of coronary artery disease (CAD), two quantitative methods for the evaluation of $^{99}Tc^{m}$ methoxy isobutyl isonitryl (MIBI) myocardial perfusion SPECT studies, bull's eye polar maps (BL) and added circumferential profiles (ACP) were assessed for their diagnostic values and compared with qualitative visual evaluations (VE) and coronary angiography results (CA), in 11 normals (six men, five women, mean age: 44±5) and 24 patients with CAD (20 men, four women, mean age: 50±9) whose CA demonstrated 50% or greater stenosis in one or more coronary arteries. Tomographic studies were performed using 180°, 6°, 30 inch data sampling technique for exercise and rest in two different days. $^{99}Tc^{m}$ MIBI percentage uptake values were obtained from apical, mid and basal parts of five myocardial segments which were determined according to the supplying coronary arteries. Percentage uptake values of normals were taken as references, considering gender differences. The following results were obtained:

CA	*n*	VE (%)	BL (%)	ACP (%)	
3 vessel	10	76	96	93	sens.
2 vessel	4	50	75	87	sens.
		75	75	75	spec.
1 vessel	10	80	90	90	sens.
		68	75	80	spec.

CA	*n*	VE	BL	ACP
LAD	21	20 (95%)	21 (100%)	21(100%)
LCX	12	3 (25%)	9 (75%)	10 (83%)
RCA	15	11 (73%)	13 (86%)	12 (80%)
Total	48	34 (71%)	43 (90%)	43 (90%)

	Sensitivity (%)	Specificity (%)	Accuracy(%)
VE	74	69	72
BL	90	75	85
ACP	91	79	87

In conclusion, between two quantitative methods no statistically significant difference was observed. But both methods are found more sensitive in the diagnosis of three vessel CAD patients and in the detection of LCX lesions than VE. Moreover, with BL and ACP analysis false positive results were less frequently encountered.

Comparison of ultrafast CT and MRI for cardiac diagnosis

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Ultrafast CT using an Imatron C-100 scanner and MRI using a GE 1.5 T Signa scanner can acquire images of the heart and great vessels with excellent spatial and temporal resolution. Image acquisition time is 50 ms for CT and 33 ms for MRI. Slice thickness is 8 mm for CT and 3, 5 or 10 mm for MRI. Eight contiguous slices can be acquired in 220 ms (CT), while cine MRI requires gated acquisition times of 256 divided by heart rate per pair of slices. CT has limited slicing planes based on table positioning while MRI can scan in any plane. Advantages of MRI are: no radiographic contrast is required; no X-irradiation is used; totally non-invasive. Advantages of CT are: no gating required; short multislice acquisition times; can be performed with irregular cardiac rhythm; safe for pacemakers and other implanted devices. CT and MRI can evaluate atrial and ventricular cavity dimensions, ventricular volumes, mass and wall motion, pericardium, hypertrophic cardiomyopathy, congenital heart disease, extra- or intra-cardiac tumours, cardiac valves, aortocoronary bypass patency and aortic aneurysms. The normal and pathological anatomy of similar cases shown by both techniques is contrasted and compared, and the physiological data derived is discussed, with advantages and disadvantages of each.

Mammography (10.45–12.00)

Mammographic and histological classification of 100 patients requiring biopsy from the Manchester Breast Screening Programme

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The mammograms and histology of the first 100 patients from the Manchester breast screening programme who have undergone excision biopsy were reviewed retrospectively. All patients underwent excision biopsy or wide local excision, 46 after needle localization. The radiological features in terms of mass type, size, location, density, clarity of margin, spiculation, microcalcification, architectural distortion and skin thickening were assessed independently of the final histological diagnosis. In the 100 patients, 56 had a radiological mass (15 with associated microcalcification), 38 showed microcalcification alone, the remaining 6 showed spiculation or architectural distortion. Forty-nine cases (age range 50–79 years, mean 60.8 years) proved malignant (39 ductal and 10 lobular carcinomas), 46 were benign (age range 50–65 years, mean 56.1 years). Five showed borderline histology, three with atypical ductal hyperplasia and two lobular carcinomas *in situ*. Of the 49 malignancies, 36 had clinically palpable masses (range 10–80 mm), with only 13 requiring needle localization. Pre-operative radiological assessment was reliable, with 41 of the 49 being graded as suspicious or malignant. Of the 46 benign cases, only 17 had clinically palpable masses, 29 requiring needle localization, mainly for microcalcification. The majority (28 patients) were radiologically uncertain. The ratio to benign to malignant biopsies performed is less than that predicted by the Forrest recommendations. The radiological features of benign and malignant lesions are discussed with reference to the implications regarding surgery and radiotherapy.

Can magnetic resonance imaging replace axillary lymph node sampling in the management of breast carcinoma? A prospective study

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The aim of this study was to compare the efficacy of surgical axillary lymph node sampling with Magnetic Resonance Imaging (MRI) of the axilla. Forty patients with biopsy-proven breast carcinoma were studied by MRI prior to surgery. Images were obtained in the axial and coronal planes using T_1- and T_2-weighted sequences. All the patients proceeded to either lumpectomy or patey mastectomy combined with axillary nodal sampling. The results of MRI were then compared with pathological findings. MRI was 100% accurate in identifying lymph node involvement in nodes greater than 10 mm in size although no cases of reactive adenopathy were present in this group. Of the remaining cases, masses less than 10 mm in size were shown in 23 cases. In 14 of these, multiplanar imaging showed vessels to be the cause of the defects, but in the remaining nine the appearances could only be attributed to non-enlarged nodes. Unfortunately chemical shift artefact obscured all tissue characterization information in the normal-sized lymph nodes and we could not therefore differentiate the four cases with microscopic evidence of tumour. Nevertheless, a protocol for MR investigation and interpretation is proposed, which could significantly reduce the number of patients who would require sampling, yet retain overall accuracy. We also report preliminary results of surface coil studies.

The individual and training in mammographic screening

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Breast cancer screening raises the questions of how best to train radiologists for the task and how appropriate is the training for each individual? During a 2-year period (1988–1989), approximately 75 radiologists attended the multidisciplinary training course in mammographic screening at Nottingham. As part of this course their film-reading ability was studied by reporting on a set of 100 screening mammograms in order to obtain a baseline performance measure. Variations in this were found as, although all participants were qualified radiologists, their experience of mammography varied from none at all to some symptomatic work. Tests of aptitude and personality assessments were also administered. Those radiologists who underwent a period of further specialist training were again asked to read the same test films. Signal detection theory was then applied to the results of both sessions, producing ROC curves for each individual. Improvements in performance were examined and correlated with the psychological test scores. Reasons for variability in the individuals' film reading performance are discussed and related to the training offered.

Mammographically demonstrated asymmetrical thickened ducts: a sign of ductal carcinoma *in situ*

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Asymmetrical glandular appearance on mammography always necessitates further evaluation. Additionally, a prominent duct pattern to the gland tissue has been associated with an increased risk of breast carcinoma. We present four cases where mammography demonstrated an area of thickened duct-like structures, broader than equivalent structures elsewhere in the same breast or in the contralateral breast. None of these areas was primarily subareolar and all were ultimately associated with mixed calcifications. Histological findings following surgical biopsy showed extensive ductal carcinoma *in situ* (DCIS) in three patients. The fourth patient's mammographic abnormality progressed over three years from the features summarized above to a mammographically malignant mass. After surgical removal, this was found to be invasive duct carcinoma. We think that this type of asymmetrical thickened duct pattern should alert the radiologist to the possible presence of extensive DCIS. Thus DCIS may be diagnosed more confidently, rather than found serendipitously at a breast biopsy instigated by the radiologist for equivocal radiological findings. Any increase in the confidence levels of diagnosis of early malignant breast disease in the context of our national breast cancer screening programme would be beneficial.

Film processing in mammography

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Optimized film processing is an important factor for image quality and breast dose in mammography. Film processing in mammography has been studied sensitometrically by varying developer temperature between 31° C and 36° C and processing time between 90 s and 240 s. Measurements were made for four brands of mammographic film and two brands of processing chemical. Contrast, relative speed, base plus fog and maximum optical density were analysed. The results show that contrast, relative speed and maximum density increase with developer temperature or processing time, but the increase owing to processing time is more significant. The toe region contrast does not behave like the other contrast indexes; the maximum is reached with long processing time and low developer temperature. Film speed varied by a factor of four within the range of processing conditions studied.

Notes

Mammographic screening: what do radiologists look for?

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Elucidating which mammographic areas have actually been visually examined in detail and which have not is a key factor in understanding the difficulties and source of errors made by individual radiologists during training for breast cancer screening. Consequently the visual search strategies of radiologists were recorded as they inspected the same test set of screening mammograms. Experts first read the films and reported on the presence of abnormalities as well as other key radiological features. Radiologists in training at the Nottingham Breast Screening Training Centre also performed the same task. The eye movement data from both groups were analysed for overall research strategy, mammographic areas examined and the amount of time spent attending to specific areas. This information was then related to the trainees' performance in reporting the films and identifying features. Variations between the trainees and the experts are considered. The data are also discussed with regard to understanding the processes underlying errors and in relation to training.

The Nottingham breast marker localization set

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Breast cancer screening has resulted in a large increase in the number of impalpable breast lesions requiring marker localization prior to open biopsy. As well as enabling the surgeon to accurately locate an impalpable lesion, marker localization should allow the surgeon to achieve the best possible cosmetic result. In our experience none of the marker techniques or equipment available are ideal for these purposes. The dye and carbon particle techniques often require the surgeon to excise a larger specimen than necessary. Hooks or curved fine wires are too easily displaced and are difficult to find within the breast at surgery. The Reidy X wire has solved these problems but may interfere with accurate pathological assessment of the excised specimen. In conjunction with Mediplus Ltd, the Nottingham breast team has developed a breast marker localization set which can be easily and accurately placed, may be left in situ without fear of displacement, is comfortable for the patient, can be easily located within the breast at surgery and can be removed from the biopsy specimen without need to dissect the specimen. We describe this new marker wire and outline its use in achieving accurate breast lesion localization.

Computer-aided interpretation of screening mammograms: a feasibility study

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Systematic mammographic analysis methods are employed by radiologists; however, significant observer variability exists and high error rates have been reported. We have investigated the feasibility of using computer-based image analysis methods to improve the accuracy and objectivity of mammographic interpretation. Computer-based image analysis techniques were developed for the detection of mammographic abnormalities, including spiculation, mass lesions, asymmetry and microcalcifications. A pilot study was also undertaken, investigating the effects of digitization and feature enhancement of radiologists' performance in interpreting mammograms with subtle abnormalities. Three radiologists independently reviewed previously unseen mammograms of 12 patients without clinical information. Prior training, using a different set of self-selected mammograms, was provided. Results show that interactive enhancement of digitized mammograms can increase diagnostic confidence, although difficulties were encountered in defining microcalcification. Methods for detecting mammographic abnormalities show potential, but require further rigorous assessment. Possible applications of this technology to mammographic screening include detection of specific radiological signs and the provision of reproducible, quantitative information about suspicious regions.

Notes

Ultrasound Studies (2.30–3.45)

The current status of transrectal ultrasonography in the diagnosis and management of diseases of the prostate

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There is a need in clinical urology for an objective imaging technique which might be applied to the prostate. Transrectal Ultrasonography (TRUS) provides a simple, safe method of assessing the prostate gland. Serial examinations have been performed on over 8000 patients with malignant and benign prostatic disease. The extent of the disease, including involvement of the periprostatic structures, has also been determined. The correlation of TRUS, microradiography and histopathology of matching slices of the cadaver prostate is used to support the interpretation of the ultrasonic features of normal and pathological states. The importance of assessing the seminal vesicles and ejaculatory ducts is also discussed. The significance of calcification in benign and malignant disease has also been evaluated. The ultrasonic volume of the prostate gland has been compared with the actual volume of the cadaver gland and the volume determined by digital rectal examination. The aims and objectives of this review are to demonstrate the value of TRUS in the diagnosis and management of patients with prostatic cancer, benign hyperplasia and prostatic inflammation. Other clinical applications such as ultrasound guided biopsy and aspiration techniques are also discussed. The importance of the size of the primary tumour in prostatic cancer in relation to prognosis is emphasized and this opens an exciting area for TRUS.

Ultrasound of the post surgical thyroid

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We present the ultrasound appearances of the post thyroidectomy neck which have not been described previously. The type of thyroidectomy (hemi, partial, subtotal or total) and pre-surgery pathology influence the post-operative appearance. Patients are examined with an SDU 7000 7.5 mHz static B-scan to produce multiple axial and sagittal slices. Our results show that ultrasound of the thyroid reveals differences in shape and texture from the normal which must not be confused with recurrence or malignancy, in particular the superior pole hypoechogenic clusters of total thyroidectomy. Frequently there are discrepancies between the ultrasound appearances and the surgical record, with ultrasound showing less of the gland removed than the surgeon described. The object of this paper is to present these various appearances to the radiologist unfamiliar with the post-operative thyroid.

Dynamic scanning in the assessment of intraocular abnormalities

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Most radiologists have access to currently available sector scanners, whose small-parts probes are eminently suitable for eye scanning. Dynamic scanning is carried out when the patient moves the eyes from side to side, which induces movements in pathological intraocular structures. Observation of these movements is of value, both in making the diagnosis, and in assessing surgical approach. The technique is of particular value when the light-conducting media of the eye are opaque to direct opthalmoscopy, for example in the presence of cataract or haemorrhage. Knowledge of the anatomy of the coats of the eye, the vitreous, and the internal attachments of intraocular structures is of great relevance when observing intraocular movements during dynamic scanning. The type of motion exhibited by some structures may be the only clue to diagnosis, and furthermore, mobility or fixity of detachments are good indicators of surgical prognosis. Although scanning the eye at rest yields useful information, vitreous detachment may mimic RD, retrogyaloid haemorrhage may mimic subretinal haemorrhage, and haemorrhage itself may mimic a choroidal tumour. Dynamic testing demonstrates the typical motion of the detached vitreous gel mass, as an elastic body, whereas the detached retina undulates as a membrane. Examples of a range of conditions are presented, amassed over the 7 years' existence of the eye scanning service, demonstrating the value of this simple technique.

The role of ultrasound in the investigation of the salivary gland

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Sialography has several disadvantages including: difficulty gaining access, the time consumed and the high false negative rate (up to 20% for tumours). Forty-five patients who presented with symptoms of salivary gland diseases studied using real-time ultrasound with a 5 mHz linear array transducer (Acuson). The normal ultrasound anatomy and relationships of the parotid and submandibular glands were defined. Each subject had sialography performed and the two methods compared. Using ultrasound, eight cases of calculous disease of the submandibular gland were diagnosed: six cases were confirmed by sialography, two had failed sialography and one case was demonstrated on sialography but not demonstrated by ultrasound. The ultrasonic appearances of sialiectasis were shown in 12 cases, 11 of which were confirmed using sialography.

Four subjects with masses in the parotid gland were assessed with ultrasound; all subjects had normal sialography. The ultrasonic appearances of the mass lesions were demonstrated, involvement of surrounding structures assessed and correlated with pathological findings. Ultrasound is a rapid method of assessing the salivary glands. It is relatively inexpensive, and surrounding structures and the other salivary glands can be imaged. It is as sensitive as sialography for calculous disease and sialectasis; and very sensitive in the diagnosis of mass lesions.

The ultrasound features of 40 peripheral haemangiomas

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Liver haemangiomas are common and the ultrasound features well known; peripheral haemangiomas are rare and the ultrasound features not well known. We describe the ultrasound findings of 40 patients with peripheral haemangiomas, all confirmed by $^{99}Tc^{m}$ RBC scintigraphy. Ultrasound was performed with an Aloka SSD 650 3.5 and 5 mHz convex probes. Scintigraphy was performed with a semi *in vitro* method using 15 mCi of Tc pertechnetate. Forty patients were examined: 10 had head and neck haemangiomas including five parotid haemangiomas; six had upper-limb and 24 lower-limb haemangiomas. All haemangiomas were demonstrated with ultrasound. The majority of limb lesions were intramuscular. The haemangiomas showed a wide spectrum of echo features: only two features were constant, namely disruption of the normal anatomy and poor edge definition. The diagnosis of peripheral haemangiomas can only be suspected with ultrasound. Confirmation of the vascular nature of the lesion is required before invasive methods are attempted.

Techniques for 3D volume imaging with ultrasound

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There has recently been considerable interest in the presentation of views of 3D sets of section images, typically from CT and MRI studies and more recently in sonography, where slow reconstruction methods may appear unsatisfactory compared with normal clinical techniques. We have developed a system based on high-speed, low-cost transputer technology, which provides for very rapid interactive manipulation of a 3D scan set. Video data is acquired and stored at near real-time rates, providing for a simple and low-cost add-on to most types of scanner. Once acquired, the 3D array of data may be immediately displayed by rapid interactive positioning of a "view section" through the data volume, in a manner similar to, but much more flexible than, normal sonography techniques, at rates of up to five frames/s. The system can also generate a range of views not available to the normal scanner, for example: as a curved section; a density projection; a shaded surface extracted from the data; or other processed formats. An immediate benefit results from the storing of complete volume information for subsequent diagnostic review or for surgical planning. Other applications include generation of novel or "inaccessible" views to resolve questions about complex structures, and quantitative measurements in 3D. We have used the system for a range of clinical investigations including endoscopic studies of the oesophagus and rectum using a standard rotating endoscopic transducer, *e.g.* to help assess tumour extent and penetration. It has also been used with a new ultrasound angioscopy system to make intravascular measurements of atherosclerotic plaque. The system can produce a standard video output, which may be recorded on videotape (examples shown).

Umbilical artery Doppler in high risk pregnancy: relationship to outcome

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Over a 12-month period systolic/diastolic ratios of umbilical artery blood flow were obtained in 119 high-risk pregnancies. The main indications for a Doppler study were: suspected or documented growth retardation, pregnancy induced hypertension and reduced fetal movements. Systolic/diastolic ratios were classified into four groups: I. normal; II. a raised ratio which subsequently returned to normal; III. raised systolic/diastolic ratio but positive diastolic flow; IV. absent end diastolic flow. Patients with absent end diastolic flow had significantly higher Caesarean section rates, and Caesarean section for fetal distress was five times higher. Fetuses with absent end diastolic flow were delivered at an earlier gestational age (33.6 weeks), had lower birth weight (1.68 kg) and spent more time on the Special Care Baby Unit (15.4 days) than fetuses with normal ratios (38.6 weeks, 2.7 kg and 1.2 days, respectively). Patients with raised ratios but positive diastolic flow were delivered of babies with intermediate values for gestational age at delivery (37.6 weeks), birth weight (2.2 kg) and Special Care Baby Unit stay (6.2 days). In conclusion, we feel that umbilical artery Doppler is a useful parameter in monitoring high-risk pregnancies. Abnormal Doppler ratios are associated with an adverse outcome.

The sonographic features of post-partum thyroiditis

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During the post-partum period there is an increased incidence of acute auto-immune thyroiditis in women with anti-thyroid auto-antibodies. This study was designed to determine the sonographic appearances and volumetric changes in thyroids of patients with post-partum thyroiditis (PPT). Thyroid ultrasound was performed in 85 women between 15 and 25 weeks post-partum using either a 5 MHz sector scanner with stand-off gel or a 7.5 MHz linear array. Patients were divided into three groups according to thyroid status: Group 1, (23) patients with PPT; Group 2, (28) patients with thyroid auto-antibodies but no biochemical evidence of PPT; Group 3, (34) age-matched controls. Mean thyroid volume in PPT patients (20.0 ml ± 2.1 ml (SE)) was significantly greater than the mean volume in both Group 2 (13.5 ml ± 0.94 ml, $p<0.01$) and Group 3 (10.6 ml ± 0.67 ml, $p<0.001$). Mean volume was significantly greater in Group 2 than Group 3 ($p<0.02$). The characteristic sonographic appearance in PPT was focal or generalized decrease in thyroid echogenicity and this was present in 22/23 patients (96%) with PPT, 11/28 (39%) in Group 2 and 0/34 in Group 3. Thyroid ultrasound demonstrates significant morphological changes in patients with PPT. Thyroid damage can also occur in antibody-positive patients in the absence of thyroid dysfunction. Sonography may have a useful role in the evaluation of antibody-positive patients during the post-partum period.

The Venetian blind sign — an unusual ultrasound appearance in uterine fibroleiomyomas

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Uterine fibroids occur in up to 40% of women over 35 years of age and ultrasound is generally regarded as the most accurate means of diagnosis. A variety of ultrasonic appearances area seen, however, and some of these may cause diagnostic difficulties by simulating other pelvic conditions. The Venetian blind sign — a pattern of alternating acoustic shadows and through transmission — is an unusual appearance of a fibroid that may occur and be confused with an ovarian dermoid. The Venetian blind appearance is also known to occur in other situations such as in the liver in hepatoma, and ultrasound/pathological correlation in these conditions is presented.

Ultrasound markers in chromosomal disease: a retrospective study

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Over a 12-month period 24 pregnancies were complicated by a chromosomal abnormality. Antenatal and postnatal scans were reviewed and post-mortem specimens were also assessed for potential ultrasound markers. All four cases of Turner's syndromes demonstrated a cystic hygroma and two cases also showed hydrops. In the two cases of Trisomy-13, holoprosencephaly with midline facial clefting, polydactyl and growth retardation were seen. In the three cases of Trisomy-18, diaphragmatic hernia and abnormalities of the extremities were common findings. Choroid plexus cysts, growth retardation and cardiac anomalies were also demonstrated. In the 14 cases of Trisomy-21 the main abnormalities were cardiac. There were three atrioventricular canal defects, one hypoplastic left heart syndrome and one small ventriculo-septal defect associated with duodenal atresia and choroid plexus cysts. In the single cases of triploidy 69xxx, the most marked finding was a large hydropic placenta. From the antenatal scans, only eight cases of chromosomal disease were suspected. However the routine assessment of cardiac structures at 18 weeks' gestation should detect more cases of Down's syndrome. The presence of choroid plexus cysts, diaphragmatic hernia and growth retardation should prompt assessment of the extremities for markers of Trisomy-18 and 13. The ultrasound markers of chromosomal disease are demonstrated with pathological correlations.

Ultrasound in the diagnosis of gallstone ileus

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Gallstone ileus accounts for up to 25% of al non-malignant causes of small bowel obstruction in those over 65 years of age and is readily treatable. The diagnosis is often a difficult one, however, and the characteristic plain radiographic features are present in only one third of cases. Recent studies have shown that ultrasound can be useful and demonstrate small bowel obstruction, pneumobilia, and ectopic gallstones which clinches the diagnosis in the absence of plain radiographic features. We present two patients from our unit in whom gallstone ileus was diagnosed by ultrasound alone. A third patient with identical ultrasonic features was found to have distal small intestinal obstruction caused by adhesions around a calcified mesenteric lymph node. Ultrasound is useful in the diagnosis of gallstone ileus when the plain abdominal radiographs are inconclusive.

Bramham Suite

Evaluation of Skeletal Metastases (9.00–12.00)

Organizer and Chairman: Dr M. Merrick, Edinburgh
Panel: J. S. M. Beales, Stevenage; N. Garvie, London; R. Leonard, Edinburgh

A practising clinical oncologist, a general radiologist and a nuclear medicine specialist review the clinical role of bone scintigraphy in lung, breast, prostate and bladder cancer and in the lymphomas. Each disease is considered separately and in depth. The panel, with the participation of the audience, attempts to come to a consensus defining the most effective use of skeletal investigations of these conditions.

Notes

Teach-in: Interpretation of Mammograms (2.30–3.45)

Organizer: Dr C. Parsons, London

The session concentrates on the implicationss of normal variants and abnormalities seen on mammograms. The essential questions are: (1) What, if anything, do you do once an "abnormality" has been observed? (2) Why are the patients managed as they are? (3) How well does the natural history of breast disease support current practice? The topics discussed include: asymmetric breast density, opacities due to overlapping normal structures, solitary smooth round opacities, fibrocystic change, ductal and lobular carcinoma *in situ*, the various apppearances of infiltrating cancers, assessing response to primary medical treatment, specimen and localization procedures.

Charter Suite

Advances in Oncology (9.00–10.15)

Conformal radiotherapy

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Improvements in the local control of tumours in a significant number of patients could be achieved by increasing the dose to the tumour. However, tumour dose is frequently limited by the tolerance of normal tissues to radiation damage, which is in turn related to the volume of normal tissue irradiated. CT shows that the tumour or target volume is generally an irregularly-shaped 3D volume which is much smaller than the box-shaped high-dose volumes (HVLs) usually prescribed. Conformal therapy aims to shape the HVL to conform to that of the target volume, thereby reducing the volume of normal tissues irradiated. The different ways of shaping the high-dose volume are discussed: custom blocking, the multi-leaf collimator (MLC), non-uniform beams and dynamic therapy. Impressive results can be achieved but at the expense of simplicity. The MLC appears to offer the most practical way of improving conformity and hence increasing local control rates, particularly for pelvic tumours.

Notes

Megavoltage imaging: New methods and applications for radiotherapy

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Herman Suit (1982) proved theoretically that cancer patients could benefit from significant and worthwhile gains in survival if treatment methods could be modified to improve local control rates. Kinzie et al (1982) confirmed this prediction, in a particular case of radiotherapy treatment, with a retrospective study of 98 patients with Hodgkin's disease. There is a strong incentive to realise these potential gains on a wider basis and conformation therapy is widely held to offer an excellent chance of accomplishing this. In conformation radiotherapy the high dose margins are narrowed and shaped to make the treatment volume conform as closely as possible to the target volume. It has the potential to improve the local control rate because less normal tissue is involved and higher doses can therefore be applied to the target. However, great care must be taken when positioning the patient on the treatment machine to ensure that the target volume (which is referenced to the patient) is correctly positioned relative to the treatment volume (which is referenced to the machine). The traditional method of verifying the position of the patient involves the use of photographic film but there is now an increasing interest in digital imaging techniques which have many advantages over film, especially in the context of high-precision treatment. Several centres around the world have been developing new methods for imaging, using the treatment beam as the source of imaging radiation, and as as result, commercial versions of megavoltage imaging systems are beginning to appear. The technical aspects of these imaging methods are reviewed and the merits of these systems relative to film discussed. Examples of clinical images and their applications are shown.

References

KINZIE, J. J., HANKS, G. E., MACLEAN, C. J. & KRAMER, S., 1982. Patterns of care study: Hodgkin's disease relapse rates and adequacy portals. *Cancer*, 2223.

SUIT, H., 1982. *Cancer*, *50*, 1227–1234.

Bladder cancer and magnetic resonance imaging

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The accurate staging of transitional cell carcinoma (TCC) of the bladder is essential in order to offer the correct treatment to patients with the condition. In particular, the detection of invasion into the muscle layers or into adjacent organs will affect both prognosis and the treatment available. The value of Magnetic Resonance Imaging (MRI) for staging bladder cancer has been studied. Thirty-six patients with a diagnosis of TCC of the bladder were studied. In each case MRI scans were obtained in three dimensions — sagittal, coronal and transverse — on a Picker Vista 2 500 0.5 Tesla scanner. The spin sequences used included T_1-, T_2-weighted and STIR (short tau inversion recovery). Clinicopathological data were obtained in each patient and included clinical stage, tumour grade and pathological stage. Pathological stage was assessed by examination of tissue obtained at transurethral resection (n=30) or cystectomy (n=17). In 22 cases the tumour was pTa or pT1 (non-invasive), in 15 pT2 or pT3 (muscle invasion) and in 10 pT4 (invasion through the bladder wall). In 41 cases the MRI scan agreed with the clinicopathological staging, in four cases the MRI scan understaged and in two overstaged the disease. MRI offers an accurate method of imaging TCC that has extended beyond the wall of the bladder. There are a significant number of both false positives and false negatives, the main problem being the differentiation of non-invasive from muscle-invasive disease. The use of a contrast agent (gadolinium-DTPA) to improve the results of imaging is also discussed.

Computed tomography in carcinoma of the bladder

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A study was undertaken to determine the role of computed tomography in the management of carcinoma of the bladder in a general oncology service in which only CT referrals relevant to clinical management were accepted. Two hundred and sixty-eight patients underwent 490 examinations between 1982 and 1989. Two hundred and twenty-two (45%) examinations were carried out for staging purposes and 205 (42%) were for CT-assisted radiotherapy planning. Examinations to monitor therapy and to detect recurrence were less common — 24 and 19 (5% and 4%), respectively. Nine (2%) were assessments prior to cystectomy. Enlarged lymph nodes were detected in 26 (5.3%) patients and were noted above the aortic bifurcation in only seven (1.4%). In no case was abdominal lymphadenopathy present without pelvic lymphadenopathy. These results have implications in the planning of examinations, and in the allocation of appointments for CT in patients with carcinoma of the bladder.

Localized recurrence of rectosigmoid carcinoma: CT and MR assessment

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Twenty patients with suspected local recurrence of rectosigmoid carcinoma were examined by CT (GE 9800) and MR (1.5T GE Signa system) to determine the value of MR and to compare the results. Spin–echo pulse sequences were obtained in the axial and, in some cases, sagittal planes within the pelvis. In 12 patients the demonstrated lesions were confirmed histologically and eight were followed up clinically (four with repeat imaging) up to 14 months. There was tumour recurrence in 15 cases and no recurrence in five. The sensitivities of CT and MR were both 87%, while the specificity of MR was 60% as compared to 40% for CT, with an overall accuracy of 80% for MR and 75% for CT. It is concluded that MR lacks specificity but it may have a role in selective cases. The methods, results and illustrative cases are presented and discussed.

Post-surgical CT images are not degraded by use of polydioxonone Ligaclips: advantages for follow-up after para-aortic node dissection for metastatic germ cell tumours

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Relapse has occurred in 51 of 205 patients with metastatic germ cell tumours treated with chemotherapy and para-aortic node dissection (PAND). The identification of site(s) of recurrent disease influences treatment and is dependent on accurate CT. While we have found the routine use of stainless steel Ligaclips facilitates PAND, they cause significant CT image degradation and thus interfere with the interpretation of post-surgical CT scans. We have therefore studied the use of absorbable polydioxonone (PDS) Ligaclips during PAND in 10 consecutive patients. CT was performed pre-

operatively in both the early (2 weeks) and later (3–6 months) post-operative periods. PDS Ligaclips were easily visible on all early post-operative scans but only faintly visible on six of the later scans, in keeping with absorption. In none of the early or later post-operative scans were PDS Ligaclips associated with any image degradation, thus facilitating radiological interpretation. No complication associated with the use of PDS Ligaclips was encountered. This study shows that PDS Ligaclips, unlike conventional Ligaclips, do not prejudice the interpretation of post-surgical CT scans. Their use increases the sensitivity for the early identification of recurrence following PAND, and can also be recommended for any operation where post-surgical imaging is important.

Notes

Localization and quantitation in magnetic resonance spectroscopy

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Nuclear magnetic resonance spectroscopy provides a "window" into the body that allows tissue biochemistry and metabolism to be monitored non-invasively. The technique is currently at an early stage in its clinical application, but is already showing promise in a variety of fields. This paper addresses applications in oncology, where the requirements for accurate localization, to acquire signal specific to particular tissues, as well as for signal quantification, to allow individual metabolite signals to be followed with disease progression and treatment, are particularly demanding. Research projects employing NMR spectroscopy in oncology are principally directed at investigating whether NMR spectra provide information of value in differential diagnosis, in monitoring the efficacy of therapeutic regimes, in monitoring the behaviour and distribution of therapeutic agents and in providing insight into the effects of therapy in the patient. The major methods of signal localization employed in NMR spectroscopy are reviewed, together with clinical examples, with particular regard to the demands of the range of applications in oncology. The importance of metabolite quantification in this field is discussed, together with methodology and practical limitations.

Use of field inhomogeneity pulse to correct line shape and broadening spectra in *in vivo* MRS

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Phase images which map field derivations (and which are a by-product of susceptibility mapping (Cox et al, 1986)) potentially provide a means of measuring line-shape and broadening effects in *in vivo* spectroscopy (MRS). We have acquired such maps of regions from which spectra are also measured and evaluated. The field maps are obtained at much higher spatial resolution than the spectra (typically at least 100 times), and the data is plotted in histogram form. This provides a weighted distribution of field against deviation, and allows a direct evaluation of the effective value of T_2^*, using the relationship $1/T_2^* = 1/T_2 + \gamma\delta B_0$. This permits a direct measure of the effective line broadening. The histogram also provides information about the deformation of the ideal Lorentzian line by the field pattern, and its use as a convolution function for simple phantom experiments is demonstrated. The method has been applied to proton spectra of phantoms where line shapes and broadening are known, to determine the terms expected and make adjustments to those obtained. *In vivo* results can be corrected in the same way, which is theoretically a preferable way of minimizing artefacts due to field inhomogeneity, since it determines the correction functions to be applied from actual measurement. Additional experimental time is needed, however, to map the regions from which spectra are to be recovered with adequate spatial resolution.

Reference

I. J. Cox et al, 1986. *Journal of Magnetic Resonance, 70,* 163–168.

Fat suppression in MRI at low field strength using binomial pulse sequences

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Suppression of the signal from fat is useful in several situations in MRI. The STIR sequence is frequently used but is not selective for lipid and is not highly T_1-weighted. A different approach involves selective excitation of fat or water and such sequences can be highly T_1-weighted to provide high sensitivity to contrast enhancement. This approach has been used at high field, but not previously at low field. We have investigated two fat suppression sequences using binomial pulses at 0.15 Tesla: (1) spin echo sequences employing a 121 90° pulse optimized to excite water; (2) a binomial 180° pulse to excite fat followed at time TI by a 90° pulse with spin echo data collect. As in a STIR sequence TI is adjusted so fat has relaxed to the null point. Images have been obtained of the limbs and pelves of volunteers and patients, showing that binomial pulse sequences for fat suppression can be applied at low field strength. However, particularly in regions with large cross-sectional areas, artefacts are more common than with the STIR sequence. A potential application of binomial sequences is to allow visualization of signal alteration due to paramagnetic contrast agents while suppressing the signal from fat.

Motion tagging by spatial modulation

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Spatial modulation of magnetization can be achieved by applying two non-selective rf pulses, separated by a short-gradient pulse, before a conventional sequence, resulting in the superimposition of a regular pattern of stripes on the image (Axel & Dougherty, 1989). The local displacement of stripes reflects the motion of that tissue in the interval between the non-selective rf pulses and the time of signal observation. Application of the technique to T_2-weighted images of the cervical spine provides a straightforward method of mapping pulsatile CSF flow around the cord and brain-stem, provided the images are cardiac-gated. Stripe separations of 6 mm, with echo times of 100 ms, show maximum displacements of the order of 3 mm, corresponding to an average velocity of 3 cm/s, in the interval 150–250 ms after the R-wave. This is in agreement with values measured using an MRI phase-encoding technique (Ridgeway et al, 1987). In its simplest form, spatial modulation superimposes a sinusoidal intensity variation across the whole field of view. Application of a series of rf pulses of different amplitudes can be used to sharpen up stripe edges, in a manner akin to Fourier series analysis of square wares. As an extension to the methods outlined by Axel and Dougherty, a method of producing stripes of variable width, shape and spacing within chosen spatial limits, is described.

References

AXEL, L. & DOUGHERTY, L., 1989. MR imaging of motion with spatial modulation of magnetization. *Radiology, 171,* 841–845.

RIDGEWAY, J. P., TURNBULL, L. W. & SMITH, M. A., 1987. Demonstration of pulsatile cerebrospinal fluid flow using magnetic resonance phase imaging. *British Journal of Radiology, 60,* 423–427.

Receiver coil and sequence choice for optimal renal allograft MR imaging

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Loss of cortico-medullary differentiation (CMD) in renal allografts as shown by magnetic resonance (MR) imaging is indicative of rejection, acute tubular necrosis or other major insult. Because of the rapid advances in MR technology, we have examined 23 patients to determine the optimal receiver and pulse sequence to demonstrate the CMD on a high field system. Fifty-eight imaging sequences were performed, 27 using the body transmit/receive resonator and 31 using a variety of surface receiver coils (spine coil, "knee" coil, "TMJ" coil) either placed directly on the skin or mounted on a special holder. Sequences included multislice dual-echo transverse (TR=2000 ms, TE=20/80 ms), T_1-weighted oblique coronal (700/26), inversion recovery coronal (2000/600/30) STIR coronal (2000/100/30) and gradient-recalled echo coronal (300/13/30° flip angle) techniques. CMD, assessed qualitatively on a scale 0–3 (not visible, just visible, well seen, very well seen), was best demonstrated by thin (5 mm) T_1-weighted oblique coronal sequences using a surface receiver coil mounted on a special coil holder. The TMJ coil proved better than the knee coil provided the kidney was superficial and not very large.

In vivo measurement of the optical parameters of tumour tissue in man

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Photodynamic therapy (PDT) is a new treatment modality which, although now at an experimental stage, may be suitable for many forms of malignant disease. In PDT, visible light (630 nm) is used to activate a photosensitizing agent present in the tumour following its systemic introduction 48–72 hours earlier. Successful treatment requires sufficient quantities of both drug and light to be present throughout the target volume. The light distribution within a treatment volume is determined by the source geometry (*e.g.* superficial or interstitial illumination) and the optical interaction coefficients of the irradiated tissue. We have measured the energy fluence rate at various points within tumours undergoing irradiation with 630 nm light for PDT for several source geometries. The relative positions of source and detector fibres were determined using CT scanning techniques. The results of these measurements were then applied to solutions of the diffusion theory which allowed the determination of the absorption coefficient ($\Sigma_a = 38.4 \pm 6.9\ m^{-1}$), the reduced scattering coefficient ($\Sigma_s' = 401 \pm 32.5\ m^{-1}$), the effective attenuation coefficient ($\Sigma_{eff} = 230 \pm 14\ m^{-1}$) and a coefficient which relates to a surface irradiance to the energy fluence at depth ($k' = 0.5$). Knowledge of these parameters allows the transmission of light through tissue to be predicted and hence the optical dosimetry of subsequent treatments to be planned more effectively.

Luminescence measurements on X-ray phosphors

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We present the latest results on the luminescence properties of a number of X-ray phosphors and discuss various problems related to the experimental estimation of these properties, including the efficiency and the resolution of the screens, the matching factors between phosphors and photocathodes and the dependence of the luminescence on the various screens and X-ray beam parameters. A report is also given on the methodology and conditions under which the luminescence properties of the phosphor are evaluated, as well as the possible errors arising during such evaluations. Comparative results are presented for excitation in transmission and in reflection. Experimental results are presented for the luminescence of a number of phosphor materials already in use and/or under investigation for X-ray intensifying screens. These results are discussed and explained on the basis of theoretical models (considering either a uniform screen or a granular one) and analytical formulae are derived permitting the theoretical calculation of the luminescence efficiency of the screens. In all cases the agreement between the theoretical and the experimental results proves to be very good.

New computer graphics for medicine and science

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Medical graphics requirements are different from those for business applications of graphics. We present a computer software package which offers not only the standard facilities but also medically-orientated features not found in business applications software. User friendliness has been enhanced to make the system easily used by anyone with minimal training. The program runs on widely available personal computers. Text and graphics are entered directly onto screen and manipulated using a mouse and a series of menus. In addition, images from computed tomography, ultrasound, magnetic resonance and high-resolution video cameras can be captured, modified and annotated. The most effective layout can be chosen by making instantaneous changes to size, position, spacing, colours, etc. Slides or negatives, in colour or black and white, are produced using a desktop film recorder with a resolution of 4096 x 2730 lines and an almost infinite range of colours. Output can also be plotted or laser-printed. Computer generation of artwork allows an image to be rapidly designed, displayed and altered to achieve maximal effect. This new software gives advantages over other current programs for medical and scientific users.

3D microscopic computed tomography

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X-ray microscopy allows non-destructive study of small (micron-size) structures. Digital capture of X-ray projection images allows further possibilities for image processing and tomography. We have combined a microfocal X-ray generator with a multi-step avalanche/multiwire proportional counter to produce a digital X-ray microscope with around 10-micron spatial resolution at the highest magnification. Samples were placed on a rotating goniometer arranged between source and detector with typical magnifications of 5–30. Projection data taken at multiple orientations have been reconstructed using cone-beam convolution-and-back-projection methods into 3D tomographic datasets with cubic voxels of typical dimensions 100 microns with currently available computer storage and speed. Experimental data-taking with the tomographic microscope is fully automatic under computer control. The tube can operate at up to 30 keV/0.1 mA. With present limitations of detector efficiency (5% at 5 keV) experimental acquisition of views at 90 orientations takes 2–3 h and limits application to *in vitro* samples. We have successfully imaged tomographically: assorted seeds, grasses, dead insects and (in a non-biological context) industrial foams (examples are shown). Present effort is being concentrated on upgrading the equipment enabling the use of higher kVp (requiring a more efficient detector) and opening up the possibility of microtomography for more radio-opaque samples. In paticular such a technique could: (1) allow investigation of the 3D architecture of breast excision samples; (2) allow *in vivo* imaging of tumours in small rodents, assisting studies of tumour growth or regression from radio- or chemotherapy without animal sacrifice.

Oncology (2.30–3.45)

The current status of radiobiological modelling

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The linear-quadratic (LQ) model possesses greater versatility than its predecessors as it shows more clearly that biological effect is not linearly related to radiation dose. The model demonstrates that the effectiveness of a given treatment type is strongly dependent on the irradiation conditions, and on a number of tissue-specific parameters. Since these parameters are generally different between tumours and dose-limiting tissues the LQ model, when backed by reliable experimental data, indicates the possibility of prospectively designing better treatments. Although much attention has been devoted to investigating the implications of the model for fractionated therapy, it also has value for analysing other types of radiotherapy, and may be used to assess continuous low-dose-rate treatments, treatments with decaying sources, and biologically-targetted radiotherapy. Whilst the LQ model must remain a much-simplified mathematical description of the many radiobiological factors which are of importance in clinical radiotherapy, its sensible application opens up a number of new avenues of evolution of radiotherapy techniques in the future.

In vitro radiosensitivity of human malignant astrocytomas

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Patients with malignant astrocytomas have a bad prognosis, and while radiotherapy will significantly increase survival, the tumours are generally considered to be radioresistant. Experiments have been performed to determine radiosensitivity as measured by surviving fraction to 2 Gray (SF 2 Gy) in short-term cultures established from 19 biopsies obtained from the patients at the time of neurosurgery. Results were compared with chemosensitivity measurements and the data were assessed for prognostic importance. Radiation response of cells was determined using a standard clonogenic assay and a rapid colorimetic assay (MTT Assay). There was considerable heterogeneity of response between the individual cultures, with the MTT assay giving values of SF 2 Gy from 0.32 to 0.86 (mean 0.56) and for the clonogenic assay 0.12 to 0.60 (mean 0.41). In each pair of readings the MTT SF was higher and the mean difference is significant ($p< 0.001$). However as a qualitative assessment of sensitivity/resistance the two methods showed a reasonable degree of correlation. Response of the cultures to CCNU and cisplatin as determined by the MTT assay also showed considerable heterogeneity, with the drug dose required to reduce the optical density by 50% (ID50) ranging from 4.5 μg/ml to 32 μg/ml for CCNU and 0.01 μg/ml to 11 μg/ml for cisplatin. There was no significant correlation between chemosensitivity and radiosensitivity, although there was a trend towards higher ID50s being associated with lower SF 2 Gy. Of the 19 patients tested, 18 received radical radiotherapy and six patients also received chemotherapy. Patients with more resistant tumours (SF > 0.5) had a shorter median survival time, but more patients are required to determine if *in vitro* radiation response is useful as a prognostic indicator in this group of tumours.

Comparison of the biological effects of LDR and HDR radiation on epidermoidal cervix carcinoma cells (Caski cells) and human primary keratinocytes obtained after transfection with human papillomavirus type 16 DNA

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To compare the biological effectivity of HDR and LDR brachytherapy, we carried out experiments on epidermoidal cervix carcinoma cells (Caski cells) and human primary keratinocytes obtained after transfection with human papillomavirus type 16 DNA, varying the dose rate (27cGy/h–8000cGy/h), the dose (1–100 Gy) and fractioning (protracted, 3, 6, 12 and 18 fractions). The results demonstrate that the LDR therapy can be compensated by the HDR therapy with the same therapeutic range if fractioning is high enough.

Radiotherapy of lung cancer: evaluation of treatment volume and tumour remission by computed tomography (CT)

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Four hundred and thirty four CT examinations of 133 patients with histologically proven bronchogenic carcinoma (22/133 with small cell lung cancer) were analysed before and after radiotherapy. The three main results are as follows. (1) For the determination of treatment volume, conventional X-ray simulator methods are inferior to CT-aided planning. We found that changes of the treatment volume were necessary in 50%, and in 22% the changes were crucial, especially in non-small-cell lung cancer. (2) Based upon the tumour volumes calculated by CT, the response rate (partial and complete remission after radiotherapy) of the primary could be evaluated: it was more than 70%. The rates of complete regression of the primary were 45% (non-small-cell carcinoma) and 67% (small-cell carcinoma). (3) 1–3 months and 4-9 months after irradiation the rates of complete remissions were 19% and 62%, respectively. Hence, the evaluation of treatment results earlier than 3 months after radiotherapy may lead to incorrect conclusions concerning tumour response.

The effect of ultrasound on the cytotoxicity of some chemotherapeutic agents

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We have demonstrated that continuous-wave ultrasound (2.6MHz, 2.3Wcm^{-2}) can considerably enhance the cytotoxic effect of adriamycin on V79 cells maintained in suspension cultures at physiologically normal temperatures. Flow cytometric studies have shown that this effect can in part be explained by an increased intracellular concentration of adriamycin. Similar studies have been carried out to investigate the effect of ultrasound exposures on the cytotoxicity of other chemotherapeutic agents at temperatures in the range 37°C–43°C. Drugs studied include daunomycin, melphalan, chlorambucil and procaine hydrochloride. The toxicity of melphalan is unaffected by ultrasound at any of the temperatures studied. The combination of ultrasound and procaine hydrochloride is more toxic at 43°C than is either agent alone at that temperature, whereas at 37°C no cell killing occurs. Ultrasound enhances the toxicity of daunomycin at 37°C but has no effect on chlorambucil toxicity at this temperature. These and other results are discussed in detail.

Radiotherapy, head and neck tumours and cigarette smoking

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Acute reactions in the mucosa of patients treated for head and neck tumours are influenced in severity by the schedule of radiotherapy and also by host factors which may include cigarette smoking. In a survey of the pattern of cigarette smoking of 41 patients receiving continuous hyperfractionated accelerated radiotherapy (CHART), a significant correlation was shown between persistence of smoking and the duration of mucositis ($p = 0.014$). There was also a correlation with the volume of mucosa irradiated ($p = 0.025$), but both appeared independent factors. It is important to encourage patients to stop smoking altogether prior to radiotherapy in order to minimize mucositis; however, many patients are very resistant. The services available to help patients give up the smoking habit are reviewed and experience gained at Mount Vernon in counselling patients prior to radiotherapy described.

The assessment of tumour volume in the management of lung cancer by radiotherapy

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In the treatment of lung cancer the tumour volume may be correlated with prognosis, and a comparison of volumes before and after treatment is also used to estimate the extent of response to treatment. In clinical practice tumour volume is usually estimated by the product of two diameters of the tumour image on chest X-ray. However, with CT a more accurate assessment of tumour volume may be obtained by using appropriate software and knowledge of the CT slice thickness and the number of slices on which the tumour is visible. Between January 1985 and November 1988 62 patients with locally advanced non-small-cell lung cancer were treated in the pilot study of continuous, hyperfractionated, accelerated radiotherapy (CHART) at Mount Vernon Hospital. From CT scans performed before and after treatment, tumour volumes have been calculated. The volumes have been compared with "volumes" calculated by multiples of two diameters on CT slices and chest radiographs. Initial volume and complete regression determined either by CT or by chest X-ray have been correlated with outcome.

A quantitative method of expressing the radiation sensitivity of the epithelium in the human oral cavity

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We have followed up 141 patients with tumours in three sites (97 carcinomas of the epipharyngeal cavity, 33 of the tonsils and 11 of the tongue base), in which the correlation between the epithelium of the oral cavity and the irradiated volume varies with a conventional course of fractionation 5 x 2.0 Gy weekly up to 60–65 Gy total dose for 6–7 weeks of telegammatherapy. In our attempt to find more general regularities and a quantitative expression of dependence between "dose — first radiation reaction of epithelium" and the time for healing, we adapted Kirk's formula for cumulative radiation effect (CRE) in out study of radioepithelitis and have found certain quantitative regularities. The epipharyngeal carcinomas are divided into two groups: with early radiosensitivity the interruption begins toward 5.0–6.0 Gy (days 0.11) of the CRE, with more days for the dying down of the epithelitis; and with later radiosensitivity, this starts after the interval of 11.0 Gy (days 0.11) and with fewer days for the fading away of the radioeipthelitis. For the epipharynx the age fluctuations are greater after 11.0–12.0 Gy (days 0.11) for an average age of 30–35 years, while with the base-of-the-tongue patients they are greater at 8. 0–11. 0 Gy (days 0.11) at an average of 60–80 years.

Notes

Congress Theatre

Mayneord Memorial Lecture (12.15–1.15)

This lecture is financed through the generosity of 3M UK plc

Conjoint application of diagnostic and therapeutic ultrasound

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New diagnostic ultrasound techniques are permitting more precise quantification of tissue microstructure in terms of the sizes, concentrations and mechanical properties of tissue elements. In ophthalmology, this information is improving diagnosis, selection of appropriate therapy, and monitoring of treatment responses. We have found that such tissue characterization information is especially important for planning and monitoring therapeutic ultrasound treatments of intraocular tumours. These treatments employ precisely focussed, high-intensity ultrasound for short-term ablation or longer-term hyperthermia. This presentation reviews the theory and practical application of tissue characterization techniques we are using for several organs; it includes recent simulations that incorporate acoustic micrograms. The theoretical model and clinical instrumentation we have developed for ophthalmic therapeutic ultrasound are discussed. Lastly, we show how our diagnostic and therapeutic results are combined, using three-dimensional computer graphics simulations to plan therapy sessions and monitor alterations induced within tumours. Preliminary three-dimensional results for other body structures (*e.g.* superficial blood vessels) are also presented.

Sylvanus Thompson Memorial Lecture (4.15–5.15)

Tumour vasculature: a bother or a boon to the cancer therapist

Juliana Denekamp
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The poor vascular supply to solid tumours has long been recognized as a common feature. It has given rise to concern about hypoxic radioresistance and poor drug delivery. Much attention has been focused on methods of improving the blood supply during treatment, or of increasing the supply of oxygen and other blood borne substances. Recently, however, several lines of work have emerged in which it appears that neovasculature may be a possible target for tumour attack. The most obvious example is interventive radiology, with deliberate occlusion of major vessels. Interfering with tumour angiogenesis factors has also been shown by Folkman and his colleagues to be a promising avenue. Hyperthermia appears to be more effective on cells deprived of oxygen and other nutrients which exist at low pH, *i.e.* features resulting from the poor blood supply. In addition, tumour vascular collapse can be induced by small temperature elevations, *e.g.* 42.5°C for 30 minutes, which would cause increased flow in normal vessels. Almost a decade ago we proposed that cytotoxic drugs could be targeted at proliferating endothelium because the endothelial turnover is 50–100 times higher than in normal vessels. Since then it has become apparent that the biochemical features of immature endothelium may also influence the possibilities of causing localized vascular collapse or occlusion, or the activation of prodrugs. Vascular effects may already be an important component in the tumour response to many existing and novel forms of therapy. These include hyperthermia, photodynamic therapy, biological response modifiers and certain cytotoxic drugs. Because these effects have been largely ignored, no attempt has been made to optimize them. The potential avalanche effect, in which ischaemic death of thousands of cells can occur for each vessel that is occluded, should not be lightly discarded. Studies of neovascular pathology, including structure and function, physiology and morphology, endothelial proliferation and differentiation and haemodynamic properties must all be brought together with this common aim.

Wednesday 13 June

Harewood Suite

Contrast Studies (9.00–10.15)

Contrast-enhanced MRI: Gd-DTPA and beyond

R. C. Brasch
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The requirement for contrast enhancement in magnetic resonance imaging is emerging as the capabilities and, more importantly, the limitations of the modality are revealed. MR parameters of normal tissues and diseased tissues overlap. Also abnormalities, when identified, lack aetiological specificity. Contrast media, by providing functional information and clues to specificity, can impact positively upon the diagnostic value of the MR examination. The most successful approach to the development of MR contrast media has been to chemically manipulate the MR tissue intensity by instilling relatively small amounts of paramagnetic or superparamagnetic substances that reduce tissue relaxation times; intensities can be made to either increase or decrease from baseline values. Depending on the biodistribution of the agent, it has been possible to enhance abnormalities of blood-brain barrier integrity, renal excretion, inflammatory foci, neoplasms, the functional reticuloendothelial mass, lymph nodes and the blood pool. Much attention has focused on dimeglumine Gd-DTPA (gadolinium diethylaminetriamine-pentaacetic acid), the first MRI contrast agent to have been used widely in clinical practice. Accumulated experience indicates that Gd-DTPA is effective for enhancement of blood-brain barrier defects, renal excretory capacity, inflammatory lesions and certain tumours, which are all well known applications for radiographic ECF contrast media. The 0.1 mmole/kg clinical dose (approximately 14 ml) of Gd-DTPA is 1/100 of the LD_{50} dose in rats, and presents a high safety index. Clinical safety is further evidenced by a very low frequency of relatively minor side effects in patients such as nausea and headache. There is no evidence of measurable dissociation of gadolinium from the DTPA chelate in patients. Demonstrated applications of ECF contrast media include enhancement of lesions in the brain and spinal cord, improved identification of carcinomas in the breast, definition of renal functional impairment, and differentiation of scar and recurrent disc disease in the post-operative spine.

Acknowledgement
This lecture has been generously supported by Schering Healthcare.

Contrast agents for diagnostic ultrasound: basic mode of action, state of the development and future prospects

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Whereas radiodiagnosis and magnetic resonance tomography (MRT) are based on interaction between electromagnetic waves and single molecules, diagnostic ultrasound is based on interactions between mechanical-elastic waves and the body tissue. This fundamentally different type of interaction led to new kinds of contrast media (CM). The known developments of ultrasound CM are based on small bubbles of air (microbubbles) which do not diffuse in the body water like X-ray CM or MRT CM, but remain within the vascular system ("blood-pool agent"). However, all known agents exhibit limited intravascular stability from a few seconds up to a few minutes. Three types of CM are in clinical use or under development: "microbubble foam" prepared immediately before injection, fixed air-filled spheres of sonicated human albumin, and microbubble-containing saccharide-microparticle suspensions (SH U 454 and SH U 508) which are prepared before injection from two components. Most advanced is the clinical development of SH U 454. More than 1600 patients have so far been investigated in the main indications of echocardiography, venous haemodynamics and Fallopian tube imaging. Clinical trials have demonstrated good tolerance and reproducible, dose-dependent echo enhancement. Although chemically almost identical to SH U 454, minor changes to the formulation of SH U 508 have led to prolonged intravascular stability and echo-enhancement of the left heart chambers and arterial vessels after intravenous injection ("transpulmonary CM"). A first clinical trial in contrast-echocardiography which has just been completed shows reproducible left heart opacification lasting dose-dependently for a few minutes and good tolerance of the SH U 508 injections. Ultrasound contrast agents, particularly those with improved intravascular stability, are expected to extend the capability of diagnostic ultrasound, *e.g.* in the broad spectrum of vascular imaging, transcranial Doppler, tumour delineation, tissue-/tumour-perfusion, urology and gynaecology.

The effect of contrast media on renal vascular resistance (RVR)

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In vivo studies in experimental animals have so far failed to dissociate the systemic effect of water-soluble contrast media (WSCM) from their direct renal effect. We have designed a new experimental approach relying on a constant-pressure recirculating model of the isolated perfused rat kidney (IPRK) to study the direct effect of Niopam 340, Omnipaque 350, Hexabrix 320, Ultravist 370, Urografin 325, Sodium Uromiro 300 and Conray 420 on the renal vascular resistance (RVR). Four kidneys of adult male Wistar rats were used to examine the effect of 10 ml of each contrast agent. Four kidneys perfused only with the physiological solution "Krebs-Henseleit with 6.7% albumin" formed a control group. All the WSCM used in this study produced changes in RVR. The high osmolar agents induced a biphasic response: a transient decrease followed by a more sustained increase in RVR; whereas the low osmolar ones produced only an increase in RVR. No change in RVR was observed in the control group throughout the experimental period (50 minutes). The increase in RVR was significant with all the WSCM and the extent of this response ranged from 20% ($p < 0.01$) observed with Niopam 340 (681 mosml/kg) and Urografin 325 (1650 mosml/kg) to a maximum of 35% ($p < 0.001$) observed with Conray 420 (2500 mosml/kg) and Hexabrix 320 (580 mosml/kg). These observations show that WSCM can exert a direct effect on RVR in the rat and that such effect is not solely dependent on the osmolality of the medium tested but may also be affected by its chemical composition.

Magnetic resonance imaging with gadolinium-DTPA in the evaluation of bone and soft tissue tumours

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Magnetic Resonance (MR) imaging is a proven technique for the evaluation of bone and soft tissue tumours. Gadolinium-DTPA (Gd-DTPA) increases signal intensity of pathological tissue on T_1-weighted sequences by shortening T_1 relaxation time. The aim of this study was to assess whether Gd-DTPA improves definition and characterization of bone and soft tissue abnormalities compared with unenhanced MR imaging. 39 MR examinations were performed in 34 patients (M=14, F=20, age 13–75 years) using a 0.26T superconducting magnet system. Spin echo and partial saturation recovery sequences (SE740–1500/40–80, PSR500/18) were used with 5–10 mm section thickness. The T_1-weighted sequences were repeated following 0.1 mmol Gd-DTPA per kg body weight. Benign bone lesions showed little change in signal intensity after Gd-DTPA but bone sarcomas and lymphoma enhanced markedly. Cortical permeation and intramuscular extension of tumour were well shown on both T_2-weighted and post-Gd-DTPA T_1-weighted scans. Intramedullary extent of tumour and the interface of extraosseous tumour with fat was most clearly defined on pre-contrast T_1-weighted scans. In the soft tissues, benign tumours generally enhanced less than sarcomas or inflammatory lesions. Tumour definition within muscle improved on T_1-weighted scans psot-Gd-DTPA but contrast with fat decreased. Unenhanced T_1-weighted sequences therefore remain necessary in MR staging protocols. In lesions which enhance, post-Gd-DTPA T_1-weighted sequences can achieve a level of contrast between tumour and muscle similar to that of T_2-weighted sequences. Omission of the T_2-weighted sequence, however, can lead to difficulty in detecting benign tumours and in characterizing tissues.

Oral magnetic particles: a new oral contrast for abdominal MRI. Clinical results

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Preliminary results using an oral medium based on a magnetite preparation (Nycomed, Oslo) were presented last year (Kean et al, 1989) which indicated that the agent showed considerable promise and provided good delineation of bowel, particularly in the upper abdomen. A Phase 2 study has recently been completed. This concentrated on the applications of the contrast medium in patients with suspected pancreatic pathology, but in addition several patients with lymphoma were examined. In patients with pancreatic disease, the agent helped to delineate the normal pancreas and was particularly useful in showing the extent of collections associated with pancreatitis, which were often difficult to distinguish in images obtained without it. T_1-weighted images were found to be the most useful and no significant image artefacts were produced by the contrast medium in any imaging plane or pulse sequence. 350 ml of contrast agent at a concentration of 0.1 g/l was sufficient to opacify the upper small bowel and colon. Pancreatic patients were examined immediately after ingesting the agent but those with lymphomas were examined 1 h after ingestion. In the lymphoma patients, the contrast was useful in delineating small bowel loops in the upper abdomen, and allowed

confident identification of small para-aortic lymph nodes. In summary therefore, this new oral contrast agent appears to outline the bowel adequately and can be recommended for routine use in abdominal magnetic resonance imaging.

Reference

KEAN, D. et al, 1989. Oral magnetic particles: a new oral contrast agent for abdominal magnetic resonance imaging. *Proceedings of the 47th Annual Congress of the British Institute of Radiology, 1989* (British Institute of Radiology, London).

Notes

The kinetics of tissue enhancement in intracranial tumours following intravenous Gd-DTPA studied by ultra-high-speed inversion-recovery EPI

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The overall effects of intravenous Gd-DTPA on tissue signal in intracranial tumours are complex, depending on dosage, time of administration, pulse sequence and tissue type. High-speed EPI permits the kinetics of tissue enhancement to be analysed for the first time. The IR-MBEST technique combines the advantages of T_1 contrast with image acquisition times of less than 1 second. Signal nulling of the tissue of interest before a bolus injection of Gd-DTPA (0.1 nmol/kg) maximizes sensitivity to T_1 shortening. The amount of blood flow to a tissue and the richness of its vascular bed dictate the "wash in" phase and are major determinants of the "wash out" phase. The rate and amount of contrast medium accumulating in the extracellular space are determined by the degree of breakdown of the blood brain barrier. Dynamic scanning has been shown to be a valuable adjunct to a morphological study of tumours, providing an assessment of vascularity which is important in planning resection; it demonstrates areas with maximal breakdown of the blood brain barrier most suitable for stereotactic biopsy, and the temporal profile of enhancement may allow discrimination between different tumour types and assessment of the malignant potential of a single type.

Ripley Suite

Technology and Optimization (10.45–12.00)

QALYs in diagnostic radiology

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We are all anxious to value the benefits of diagnostic radiology so as properly to plan pathways in the management of diagnostic problems. A large number of variable appear when costings are attempted. Some of these are the cost of the investigation, the cost of subsequent treatment, the cost of alternative methods of diagnosis, the value of a human life, the discounting of a harm which only appears after many years, the value of reassurance, and the value of the making of diagnoses. The valuation of a QALY (or quality-adjusted life-year) is used to indicate priorities in different possibilities of health spending. A QALY can represent one year of extended life, or proportionally, a period of reduced disability. The disability is graded so that for example, a person unable to undertake any paid employment with severe mental distress is rated at a loss of 0.3 (healthy = 1, dead = 0). Thus if such a person's health is improved to normal for 10 years, three QALYs are scored. Because of the variables noted above, QALYs are not suitable for general use in diagnostic radiology, but can be used to compare population screening methods: for instance, population screening for breast cancer or abdominal aortic aneurysm. It is found that the aneurysm screening gives better value than breast screening.

A new personal computer based image transfer system: impact on patient management

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The value of a new personal computer based image transfer and storage system in a regional neuroradiology department is described. The immediate impact on patient management was analysed prospectively for 149 CT scans transferred over 4 months. Sixty-eight scans were of acute neurosurgical referrals from six linked District General Hospitals; seven were follow-up scans; 50 scans were from radiologists in these hospitals seeking specialist advice from a neuroradiologist; 23 scans were sent to the homes of the neuroradiologists for primary opinions on patients in the base hospital. Overall 56 scans (37.6%) were transferred outside normal working hours. For the acute neurosurgical patients, in 55 cases (80.9%) a significant change in management occurred, principally prevention of transfer when no neurosurgically correctable lesion was present (42.6%) or arrangement of interval transfer for further investigation. Of scans transferred for a radiological opinion, in 38 cases (52.1%) a significant change in diagnosis or management results: 56% of second opinions, 43.4% of primary opinions. The use of the system steadily increased during the period of the study, and is currently two to three cases daily. We believe it offers invaluable assistance to both radiologists and clinicians and has had a major impact on patient management.

Memory for radiological appearances; objective evidence for perceptual schemata

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Our memory of a particular radiological appearance probably does not resemble a photographic copy but is rather a reconstruction or "schema" derived from stored information, which records the spatial relationships within the image and also reflects a number of stored propositions which contain our prior interpretation of the image. The following experiment provides objective evidence for the existence of such schemata and of our ability to manipulate them in problem solving. Fourteen patients were shown at random an AP view of either a left or a right knee at different orientations taken from 45° steps around a circle. Whilst the same array of features is present at all stimulus orientations the reaction time to identify which had been presented was different for each position. One group produced the fastest correct recognition times with the conventional upright radiographic film, while for a few individuals the reverse was the case. These results imply that an internal representation of the knee or schema is rotated into congruence with the perceived image prior to interpretation. The rates of rotation found varied from 200°/s to 415°/s with a mean value of 323°/s.

"Reporting in a flash"

A. G. Gale, J. Vernon, * K. Millar and B. S. Worthington
*Departments of Radiology and * Behavioural Science, University Hospital, Nottingham NG7 2UH*

Three groups of subjects — radiologists, radiographers and medical students — each viewed 100 chest radiographs, 50 of which contained abnormalities under 3 different conditions: firstly, with a 200 ms tachistoscopic exposure; secondly, with a 200 ms tachistoscopic exposure followed by the presentation of a visual noise mask to eliminate any after-image; and thirdly, viewing for an unlimited time. The subject's response to each film was given on a 5-point rating scale and an ROC curve was plotted for each subject under the three different viewing conditions. The performance of the radiologists and radiographers was significantly better than that of the students. There was very little difference in the results for each of the three groups under the different viewing conditions. These results emphasize the importance of a well-developed schema in interpreting radiographs and the great significance of peripheral vision in preliminary assessment of a film and in directing subsequent fixations. Furthermore, the findings indicate that earlier work has underestimated the amount of information which can be assimilated in a single fixation.

Patient expectation and accident and emergency radiology

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Five hundred patients who were not referred for radiology following a head or ankle injury were sent a questionnaire. 53% of the responders had expected an X-ray examination (Group 1). Important differences are shown between these patients and those who did not expect radiography (Group 2). These included: a higher level of disappointment (75% vs 0%) and more critical comments (83% vs 17%) and, following head injury, a longer mean recovery time (15 days vs 4 days). But there were very large differences in duration between age groups. For example, for those in their teens, symptom duration was nine times longer for Group 1. This could well have important educational implications. Initial analysis suggests that the overall severity of head injury was not any different between the two groups, and follow-up has shown that no important abnormality had been missed by excluding radiography. These results have implications for all casualty departments, and perhaps particularly for those who introduce guidelines which subsequently produce a reduction in X-ray examinations. Some strategies (mainly to improve communication skills) which might reduce the overall level of patient dissatisfaction are proposed.

Ergonomic assessment of mobile X-ray units

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Four currently available mobile X-ray units were examined with regard to operator ease of use. The criteria on which performance of the equipment was judged included operator comfort, safety, speed with which the equipment could effectively be used and the health and safety of the operator. Consideration was also given to cognitive aspects of the tasks involved. Three separate approaches to the evaluation were undertaken; 160 questionnaires were distributed to experienced radiographer users, participative discussion groups and user trials. In the latter, naive users were videotaped as they carried out two surrogate radiographic examinations using two of the units, and then retrospective protocol analysis was applied to the users' commentary as they watched their video record. Analysis of quantitative and qualitative data revealed areas of significant design inadequacy in all of the mobiles. These mainly concerned difficulties with unit manoeuvrability and X-ray tube movement.

Radiology in developing countries. Three years experience in Rwanda with a basic radiology system specifically designed for developing countries.

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We describe our experience of a radiographic system that we have specifically designed for developing countries (or military use) and used for three years in a small hospital in Rwanda. The Basic Radiologic System (BRS) consists of a mobile and detachable X-ray examination unit for radiography combined with a panel-type fluoroscopic intensifier and eventually completed by a linear echograph. This equipment fulfils the requirements of developing countries as well as disaster situations (either traumatic or infectious) outside the third world. In particular, the versability and the modularity of the system are emphasized. We review the efficacy of the system for abnormal disease (often parasitic or gynaecological, as well as for major current pathology.

Potential savings from improved reporting practices in a radiology department

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62% of the imaging investigations of our department are those of Körner group A. A study has been undertaken to quantify the benefits of modification of the work patterns of such reporting. Two radiologists each reported 50 randomized Körner A investigations either in a quiet room or while in a reporting area centrally within a working suite. In the quiet room, the current and any related past films had been mounted on a film alternator by a clerk. Each radiologist then crossed over films and reporting conditions to provide internal control. Time spent reporting films was reduced by 49-56% if reported in quiet surroundings. Time spent typing the reports from quiet surroundings was reduced by 10%. The cost of clerical assistance was outweighed by the financial savings thereby incurred.

Audit of a radiodiagnostic department: a pilot study of the Bristol Royal Infirmary

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To improve any service, it is necessary to identify areas of suboptimal performance and to provide a baseline against which improvements can be measured. Quantification of such material in a medical setting is difficult but in this pilot study, the "quality" of the request card, radiography, radiological report and film bag/report folder have been chosen as markers to provide indices of clinician input, and the performance of radiographic, radiological, secretarial and clerical groups of departmental staff. Twenty-five parameters of quality have been identified from these marker areas, using the investigation of 1 patient/week taken from each of 10 Körner groups in a 10-week period. The data were audited, numerically encoded and analysed. A system was developed which scored the assessment for each item of the process monitored as -1, 0 or +1. For each item a total index was obtained by adding all the scores and calculating this as a percentage of the total possible score. Arbitrary minimum satisfactory levels were set for positive and negative indices. In this way, areas of suboptimal as well as unforeseen areas of good performance from each staff group have been identified. The benefits of such work and problems incurred in the design of such a project are discussed.

Outpatient angiography in a district general hospital

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Outpatient angiography in patients with peripheral vascular disease can be a safe and cost-effective procedure. We report on 50 patients who were being investigated for peripheral vascular disease, who underwent angiography via the femoral arterial approach. We outline our patient selection protocol, techniques and post-procedure care. Doppler pulse pressure ratios were used to monitor the patients pre- and post-angiography. Their use and efficacy in detecting possible complications are discussed. No patient had a significant complication of the procedure and the technique was tolerated well, which compares favourably with previous work performed abroad. Our study shows that femoral angiography performed on a day-care basis is a safe and cost-effective technique. The financial savings are significant, and in today's health care climate it is a technique which could be practised more widely.

Notes

Harewood Suite

Digital Radiology (2.30–3.45)

Digital subtraction dacryocystography

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Imaging of the lacrimal system by conventional dacryocystography can be unsatisfactory. A technique of digital subtraction dacryocystography (DSDCG) is described. Twenty-one patients presenting clinically with obstructive epiphora were investigated with DSDCG. We found that the technique is simple to perform, is accepted well by patients and provides diagnostic images with improved demonstration of the proximal lacrimal system over conventional dacryocystography. DSDCG produces diagnostic images on a single radiographic projection, delivering a reduced radiation dose to the orbit without the need for lead eye shields. There has been complete correlation between surgical and radiological findings in patients diagnosed as having lacrimal duct obstruction on DSDCG referred for dacryorhinostomy

Digital subtraction imaging of the investigation of the salivary glands

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Contrast sialography is an established technique in the delineation of the duct system of the salivary glands. In recent years ultrasound and computerized tomography have played an increasing part in the investigation of pathology of the salivary gland parenchyma. Digital subtraction imaging (DSI) represents a refinement of existing techniques which can elegantly demonstrate ductal and glandular disease. The principal advantages of the procedure are its speed and technical ease. The patient can be screened into the ideal position, and imaging during injection of contrast agent confirms accurate positioning of the cannula. An appropriate imaging sequence allows all phases of ductal filling to be visualized on a single injection. Digital subtraction of bony structures may reduce the need for multiple projections, and results in images of excellent quality. Digital subtraction sialography is fast and easy to perform; it involves no increase in radiation exposure or patient discomfort. The technique is described in detail and a range of common pathologies illustrated. In our experience, DSI of the salivary glands is the technique of choice, where it is available, and can easily be incorporated into the timetable of a busy DSI department.

DSA of digital ischaemia

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We report on a prospective study of digital subtraction angiography (DSA) in 32 patients presenting with digital ischaemia. Direct brachial puncture was performed in 26 cases. We injected low-osmolality contrast material (Hexabrix 160) at a rate of 5 ml/s for a total of 20 ml for each injection. Nine prostaglandin E_1 angiograms were obtained to get good peripheral filling, particularly in patients presenting with vasospastic disorders. In this series, owing to instant magnification, we were able to differentiate small emboli, atherosclerosis, Buerger disease, collagen vascular diseases and other entities affecting the arteries of the hand. Since the injection of low-osmolality contrast material is painless, DSA confirmation of digital ischaemia is available on an outpatient basis, without any premedication.

Digital fluorography: the first year's experience

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In April 1989 a 1024 x 1024 digital fluorographic unit with on-line computer enhancement of images (Philips DSI) was installed at the General Infirmary at Leeds. This was the first installation of its kind in the world outside the Netherlands and uses image processing algorithms developed by the Department of Medical Physics at the University of Leeds. Field sizes of 14, 10 and 6 inches are used and computer enhanced images are available for immediate review in either single or multiple formats. In the first year since installation over 900 upper gastrointestinal barium studies, mainly double contrast barium meals, and 400 ERCP examinations, over half of them therapeutic procedures (Sphincterotomies, stone extractions, endoprosthesis placements) will have been performed in addition to over 100 other spot film contrast examinations. An evaluation of digital fluorography is presented with special reference to image quality and ergonomics. The high definition monitor and immediate image review facility permit confident diagnosis at the time of examination. Additional views can be obtained whilst optimal examination conditions persist. Ergonomic analysis of barium meals has shown 31% reduction in examination time, 49% reduction in patient waiting time and 45% reduction in patient dosage compared with conventional fluorography.

A review of thermal-processed paper/film hard-copy units in medical imaging

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Thermal hard-copy units can provide quickly-available, low-cost images and several different types have been evaluated on behalf of the Department of Health. These utilized either a thermal-head print unit or laser printing with subsequent thermal development of the image. The media were paper or film specific to each imager. Appropriate test images were produced for the measurement of image geometry, unsharpness and grey-scale characteristics. Geometric distortion was not found to be significant either horizontally or vertically (the latter relating to the paper transport mechanism). Unsharpness was determined in the thermal-head units by the physical spacing of the thermal elements, from 6 to 11.8 dots per mm. The laser-printed images had a maximum resolution of 10 pixels per mm. Spurious artefacts were sometimes produced when imaging bar-patterns of particular spatial frequencies. Grey-scale levels ranged from 16–128 for the thermal-head imagers, with 256 for the laser printer. The grey-scale characteristics (with optimally adjusted Brightness and Contrast controls), showed considerable variations in linearity between the units. For some clinical images however, overall linearity was less important than the localized gradient for discriminating diagnostically-significant details..

A physical assessment of the imaging performance of the DSI digital fluorography system

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We have carried out a physical assessment of the imaging performance of a DSI digital fluorography system. To support this project we have developed a set of X-ray test objects matched to the imaging characteristics of the DSI unit (parameters measured include signal-to-noise ratio, contrast sensitivity, dynamic range, geometry and MTF). The DSI was installed in the Diagnostic Radiology Department to provide a routine clinical service in a number of R & F examinations. Physical analysis of the test image data was performed off-line in the FAXIL laboratory using a PC-based image processing workstation. Aspects of the DSI performance evaluated include: radiation exposure calibration, subjective and objective measurement of image quality, image acquisition protocols, image processing and display facilities, video (cf laser) hard-copy media, image storage capacity, user interface and ergonomics. Results from the DSI are compared with those produced by conventional (film-based) R & F systems, and techniques which have been developed to optimize DSI image quality in clinical service are discussed.

Acknowledgments
The Supplies Technology Division of the Department of Health and Yorkshire Regional Health Authority, who support this project.

The influence of intravenous DSA in the management of peripheral vascular disease

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A retrospective study of all patients who had a digital subtraction angiogram (IV DSA) in 1987, was carried out to assess the way in which IV DSA has replaced conventional angiography in the investigation of peripheral vascular disease (PVD). 155 patients underwent IV DSA, 140 had PVD and 15 had abdominal aneurysms. In addition, 71 patients had conventional arteriography and were not investigated by IV DSA. The distribution of PVD was aorto-iliac (AI) 36 (26%), femoro-popliteal-distal (FD) 68 (48%) and mixed AI and FD, 36 (26%). IV DSA was sufficient for the management (ie diagnosis and surgical treatment) in 95% of AI disease, 72% of FD disease and 94% of mixed disease. IV DSA was the only investigation needed in 117 of 140 patients (84%) and in 68 of 72 patients (93%) with AI disease. Although IV DSA was less accurate in defining distal disease, it was sufficient in the management of 94% of those with mixed disease because the proximal disease was treated first. Furthermore, unsatisfactory definition of distal run-off only required a simple femoral angiogram. Conventional angiography was performed in 101 patients investigated for PVD in 1987, compared to 200 in 1982, before IV DSA was introduced, even though more patients with mild claudication are now studied to assess their suitability for angioplasty. IV DSA has, therefore, significantly reduced the requirement of conventional angiography in the investigation of patients with PVD, thus avoiding hospital admission and reducing cost and morbidity.

Real-time digital peripheral angiography

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A new technique for performing peripheral angiography, utilizing real-time pulsed digital imaging, is described. The equipment used is a Philips Digital Cardiac Imaging System, operated via an Optimus M200 console. The patient lies supine on a fully floating table top, with an absorption wedge and bolus bag between his legs to reduce flare. The common femoral artery is cannulated using standard Seldinger technique, and a 4.5F catheter is introduced into the lower aorta. A pump injector is loaded with 60 ml of either Ioxaglate 320 or Iopromide 300, according to allergic history. Digital acquisition is commenced at the lower aorta and the contrast agent is injected. The table is moved to follow the contrast column as it passes down the legs. Information is acquired at 12.5 frames/s onto a 512 x 512 matrix. Repeat runs, oblique views, or subtraction sequences may be performed, but are rarely required. Selected images are transferred to hard copy using a DuPont Opti Imager. The software allows for post-processing of the images and severity of stenoses may be calculated. The technique is quick and straightforward and provides a rapid method for accurate assessment of the peripheral arterial tree.

Early experience with a prototype (2K) projectional digital chest unit: ROC study of simulated lung nodules

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A Konica KDD dedicated digital chest unit has been in use in the Department of Radiological Sciences for the last 12 months. This unit generates high-resolution images of 2048 x 2462 x 10 bits which can be viewed either on 2048-line interactive monitors or as hard copy from a laser film printer. With the proposed implementation of totally digital radiography in the Division of Thoracic Imaging at UCLA, the Konica KDD was formally compared with a conventional chest unit. Using receiver operating characteristic (ROC) analysis, we compared observer performance using conventional analogue film and digitally acquired 2K images (on both interactive monitors and hard copy film) for the detection of simulated pulmonary nodules projected on an anthropomorphic chest phantom. For each display condition there were 46 images of solitary nodules with various degrees of conspicuity: high surrounding contrast (n=18), low surrounding contrast (n=19) and no nodule (n=9). In each case four observers recorded the presence or absence of a nodule using a six-point confidence scale. Diagnostic accuracy was similar for analogue film and 2K digitally acquired hard copy. Accuracy of diagnosis in the detection of simulated pulmonary nodules tended to be slightly better with the interactive video display than with digital hard copy.

Notes

Interventional Radiology (10.45–12.00)

Percutaneous angioscopy of peripheral and coronary arteries

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Using a variety of flexible fibreoptic endoscopes, 64 separate angioscopic examinations were carried out percutaneously on 23 patients with peripheral vascular disease before and after interventional treatment. Arteries examined were tibial, (2), iliac (3) femoral and popliteal (22). Ten patients underwent laser angioplasty with a sapphire tip modified ND-YAG laser, eight underwent Kensey dynamic angioplasty and five, balloon angioplasty. Tibial angioscopy was achieved using an 0.5 mm angioscope; the other arteries were examined with either a steerable 2.2 mm angioscope or 1.4 or 1.8 mm non-steerable systems. Best results were achieved with a new integrated angioscopic system (Olympus AF system) which consists of a fully immersible angioscope directly connected to a camera system without an eyepiece. A reduction in volume of fluid perfusate was achieved by the use of an angled guiding catheter system (Cordis Corp.) which allowed for placing of the angioscope at the site of interest, and limited steerability. This guiding catheter system introduces the possibility of carrying out therapeutic procedures under angioscopic guidance. Seven coronary examinations were carried out percutaneously with either a 0.5 mm angioscope (4) or a 1.4 mm angioscope (3). The larger angioscope proved more successful in allowing for adequate endoluminal coronary imaging. Both peripheral and coronary angioscopy provided information on the endoluminal appearances that was not appreciated angiographically.

Mechanical recanalisation of peripheral vascular occlusions after guide wire dissection using a metal laser probe.

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Subintimal passage of the guidewire during attempted recanalisation of peripheral vascular occlusions often presages failure. We have successfully recanalized the true lumen in some such cases by using only the mechanical properties of the thermal laser probe. In 14 cases (12 femoro-popliteal, two iliac) where the guidewire had passed subintimally, all attempts to recanalize the lumen with various guidewires and catheters failed. Prior to abandoning the procedure, the laser probe was used without laser energy, and successfully recanalized the lumen in all but two cases (10 femoro-popliteal, two iliac). In one of the iliac occlusions we did not proceed to balloon dilatation for fear of iliac rupture. Follow-up has ranged from 2 to 48 months (mean 11 months). Eight out of the 11 cases who underwent balloon dilatation remain patent clinically. Two have recurred, one at 6 months and the other at 10 months. One was lost to follow-up. The use of the laser probe as a mechanical tool to "rescue" failed conventional recanalization owing to dissection has not previously been reported. We presume that the configuration of the probe allows re-entry of the lumen by finding the correct tissue plane. We believe this to be a useful technique and the development of a wire or catheter with similar mechanical properties would be both helpful and less costly.

Technique and complications of direct brachial artery puncture for arteriography

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Direct brachial artery puncture is being used increasingly for arterial access in day-case patients and patients with severe aorto-iliac disease. In expert hands low complication rates are reported, but the risks of brachial artery puncture may be higher when performed by less experienced operators. Over a 2-year period 49 direct brachial punctures were performed for arteriography. In 27 cases the catheter was inserted directly over a guidewire while in 22 cases an introducer sheath was used. Significant complications requiring active treatment or surgical intervention occurred in three cases where direct catheter insertion was used. There were no complications when an introducer sheath was used. Causes of complications, and aspects of puncture technique to reduce the risk of them, are discussed and illustrated. Direct arterial introduction of catheters into the brachial artery can be associated with an unacceptable incidence of complications, and the risk is reduced by the use of an introducer sheath.

Dynamic angioplasty in vascular occlusions: patient selection and follow-up results

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Twenty-one male patients with occlusive vascular disease (aged 55–76) were treated with Kensey dynamic angioplasty after the failure of conventional balloon and guidewire methods. Seventeen of these patients had discrete occlusions with a visible distal vessel from collateral run-off (three iliac and 14 femoral/popliteal lesions, length 3–18 cm); 12 of these had successful procedures. In the five unsuccessful cases there were three dissections, one perforation and one failure to cross the lesion. There were 2/12 reocclusions after 3 months, and angiography at 6 months revealed 5/7 patent arteries with one patient having a small false aneurysm. Average ankle brachial index (ABI) for the successfully treated group at 3 months was 0.8 ± 0.042 (n=9) compared to the pre-Kensey average ABI = 0.61 ± 0.04. (n=12, $p > 0.05$). Average isotope limb blood flow at 3 months was 7.76 ml/100 g tissue/min (n=8) compared to 4.6 ml/100 g tissue/min before treatment. Percutaneous angioscopy of the two reocclusions revealed a primarily thrombotic lesion with some atheroma. In four patients treated with femoro-popliteal occlusions there was no popliteal run-off. Only one of these cases was successful, the other three resulted in dissections. The successful case reoccluded after 48 h. We conclude that the Kensey catheter can be used successfully in totally occluded vessels provided there is adequate distal run-off.

Treatment of chronic coronary artery occlusions with an olive-tipped guide wire (Magnum) or a Terumo guidewire

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Four women and one man with chronic right coronary artery occlusions were treated either with an olive-tipped 0.22 thou. inch guidewire and balloon system (Magnum, Schneider) (four cases) or with an 0.35 thou. inch hydrophyllic guidewire (Radiofocus guidewire, Terumo). The length of occlusion was 2–4 cm and all occlusions were treated in the proximal right coronary artery. In all three cases treated with the Magnum wire, the wire failed to cross the occlusion; in one case the procedure was discontinued because manipulation of the wire and guiding catheter after an unsuccessful attempt to re-cross the lesion resulted in dissection of the coronary osteum. In the other two cases the occlusion was successfully crossed using the Terumo wire. In these cases, balloon angioplasty was carried out by guiding an 0.14 wire down the track created by the Terumo wire. Follow-up angiography demonstrated a patent lumen with a dissection in the area of the previous occlusion. Both patients experienced relief from angina. Two more patients were treated with the Terumo wire without prior attempt to cross the lesion with the Magnum wire. These lesions were also successfully crossed with the Terumo wire followed by balloon angioplasty resulting in a patent lumen. We conclude, from our limited series of patients, that the Terumo wire is more effective than the Magnum wire in re-opening chronic coronary occlusions.

The influence of Nd-YAG laser and dynamic angioplasty devices on platelet reactivity

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The interaction of laser and dynamic angioplasty devices with arterial wall is the focus of many studies; however, their effects on surrounding blood are largely unknown. We investigated the influence of a dynamic angioplasty catheter with a fast rotating tip, the Kensey catheter (KC), and CW Nd-YAG laser (with sapphire tip) on platelet function. Blood from healthy volunteers was citrated and divided into 5 ml samples of whole blood (WB) or platelet-rich-plasma (PRP). These were exposed to Nd-YAG laser pulses of 10, 25, 50 or 100 Joules. Similar samples were exposed to KC rotating at 20, 40 or 80 thousand RPM, for 30 or 60 s. Control samples were exposed to the appropriate device without activation. Platelet Count (PC), Platelet Aggregate Ratio (PAR) and Platelet Aggregation to collagen in WB and PRP were obtained in all samples. KC caused inhibition of aggregation in WB and PRP proportional to speed and duration ($p < 0.001$). A similar effect was obtained with laser energies over 25 Joules ($p < 0.001$), lower energies potentiated aggregation ($p < 0.01$). There was no change in PC or PAR to account for either phenomenon. Transmission electron microscopy showed no significant platelet disruption or release of granules. We conclude that exposure to these angioplasty devices inhibits *in vitro* platelet aggregation, without apparent loss of the integrity of platelet structure. This phenomenon and its clinical implication justify further study.

Percutaneous peripheral laser angioplasty using an Nd-YAG laser and sapphire-tipped device

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A multipurpose continuous wave Nd-YAG laser (Surgical Laser Technologies) coupled to an optical catheter with a transparent sapphire contact probe, has been used to recanalize 25 total femoro-popliteal occlusions in 20 patients with severe claudication (17), rest pain (three) and ulceration (two). These occlusions were 3–35 cm in length (median 8 cm), and resistant to conventional angioplasty. Recanalization was successfully achieved in 20 lesions (80%) and the resulting channel improved by balloon dilatation. In these patients the mean ankle-brachial Doppler pressure index (ABI) rose from 0.51 ± 0.06 to 0.81 ± 0.05 ($p < 0.001$). There was one reocclusion within 72 h, four lesions reoccluded within 2 weeks, one at 1 month, and one at 6 months. Therefore during a median follow-up period of 3 months (range 1–7 months), 13 treated vessels remain patent with symptomatic relief (clinical success 65%). Measurement of limb blood flow (LBF) in these patients, using an isotope and gamma camera, demonstrated a rise from 4.2 ± 0.6 (before) to 9.0 ± 0.9 ml/100 ml tissue/min (1 month after) ($p < 0.001$, normal = 10). The five technical failures were either due to vessel dissection without re-entry (3), or perforation (2). However, there was no requirement for acute surgical intervention in either primary failures or reocclusions. Furthermore, there was no significant deterioration in the patient's symptoms, ABI, or isotope LBF following failed laser angioplasty. In conclusion, this general-purpose laser system is safe and effective for percutaneous recanalisation of peripheral occlusions. Results of longer follow-up are awaited.

Is iliac angioplasty indicated for the treatment of critical ischaemia?

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During an 8-year period (1981–1988), 49 iliac angioplasties were performed in 45 patients with critical ischaemia (M:F=34:12, median age 67 years, range 43–85 years). A successful dilatation with clinical improvement was evident in 24 cases (Group I); in 25, the initial angioplasty was unsuccessful (Group II). There was no significant difference in the presenting symptoms or superficial femoral artery patency rates between the two groups. Despite the 24 initial successes in Group I, eight limbs (33%) required a further procedure for disease progression (six surgical, two angioplasty). At 30 days, clinical improvement was noted in 17 limbs; four limbs (17%) had been amputated and three patients (13%) died. In Group II, significantly more limbs required urgent surgery (17) or repeat dilatation (four) ($p < 0.001$, χ^2 + Yates' correction). There was also a significantly reduced 30-day success rate within this group ($p < 0.005$, χ^2 + Yates' correction), with clinical improvement noted in only seven limbs (28%). Seven major amputations were required and four patients died. This study confirms the poor results of iliac angioplasty in the presence of critical ischaemia. In 55% of limbs the superficial femoral artery was completely occluded and iliac angioplasty was not able to improve the inflow sufficiently to allow symptomatic relief. Furthermore, operative intervention for failed angioplasty was associated with a significantly reduced success rate, and appreciable morbidity and mortality.

Lipiodol-assisted ultrasound guided liver biopsies

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Computerized tomography (CT) of the liver following the administration of Lipiodol into the hepatic artery is a widely used technique for staging hepatomas. Unfortunately both benign and malignant lesions accumulate Lipiodol. We see four new hepatomas each week in this department and only a very small proportion are operable. If the patient is considered suitable for surgery following initial ultrasound (US) staging, angiography with Lipiodol and subsequent CT are undertaken. A nodule that contraindicates surgery requires histological confirmation of malignancy. The biopsy of small hepatic lesions using CT is difficult. The intention of this work is to determine if lesions containing Lipiodol can be visualized and subsequently biopsied using US. Correlation with CT in seven patients, and the use of an original staining technique that allows Lipiodol to be seen on histological sections, have demonstrated that Lipiodol can be visualized using US. We have biopsied focal lesions that were not apparent on the initial US in five patients, and directly injected contrast medium into a suspected 4 mm haemangioma under US guidance. Using this technique, two patients were considered suitable for surgery who had previously been thought to be inoperable. The staging was confirmed to be correct at surgery. We also demonstrate Lipiodol accumulation by haemangiomas and regenerating nodules.

Notes

Radionuclide limb blood flow measurement in the assessment of balloon angioplasty in peripheral vascular disease

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A group of 25 patients underwent 28 balloon angioplasty procedures on stenotic lesions of the iliac, femoral or popliteal arteries. The extent of their disease was assessed clinically, angiographically and by radionuclide limb blood flow measurements (Parkin et al, 1986). The mean pretreatment flow below the knee in the affected leg was 5.1 + 2.5 ml/100 ml tissue/min (normal range 10–20 ml/100 ml/min). In 18 patients who showed a significant clinical improvement, limb blood flow increased by 54% after treatment. In seven patients who showed no clinical improvement, the flow was unchanged. Radionuclide limb blood flow measurement provides an objective measurement of treatment response following balloon angioplasty.

Reference

PARKIN, A., ROBINSON, P. J., WIGGINS, P. A., LEVESON, S. H., SALTER, M. C. P., MATTHEWS, H. N. D. & WARE, F. M., 1986. Measurement of limb blood flow using technetium-labelled red cells. *British Journal of Radiology, 59*, 493–497.

Ripley Suite

Oncology (2.30–3.45)

Radiotherapy for soft tissue sarcomas

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The optimal treatment for soft tissue sarcomas is wide surgical resection. Such optimal surgery will be followed by local recurrence in 40 to 60% of patients unless radiotherapy is also given. At some anatomical sites, and for very large tumours, enucleation is the most that can be achieved, and this will be followed by recurrence in 90% of patients without radiotherapy. Even radical surgery is associated with 28% risk of recurrence without additional treatment (following amputation, only 8%). Radiotherapy is, therefore, usually required except for low-grade tumours where good margins of clearance have been achieved in all three planes. For non-metastatic extremity soft-tissue sarcoma, the 5-year local control and disease-free survival rates for previously untreated patients are 87% and 74% respectively. The control rates at other sites are less favourable, although even where no surgery is possible, about one-third of patients will be controlled by radiotherapy alone. High-dose large volume irradiation is mandatory and, to avoid significant morbidity, meticulous attention to planning is essential, using a shrinking field technique. All patients must be seen in consultation with the surgeon, preferably pre-operatively. Pre-operative radiotherapy can render an initially inoperable tumour removable, although there is no apparent radiobiological advantage in routinely delivering radiation before surgery. Methods of increasing the effectiveness of radiotherapy have yet to meet with success.

Preliminary results of prospective study of hyperfractionated high dose radiotherapy in the management of extremity soft tissue sarcomas

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The RMH Sarcoma Unit manages adult extremity soft tissue sarcoma by limb conservation where feasible. Wide surgical resection is usually combined with large-volume post-operative radiotherapy to 60 Gy in 30 fractions in two phases. Where the tumour is inoperable at presentation, 50 Gy in 25 fractions is given pre-operatively. We have previously reported 85% 5-year local control with this policy. In an effort to improve these results with higher doses of XRT, 29 patients (15 male, 14 female, median age 60, range 20–84) have been entered in a prospective hyperfractionation study using 1.25 Gy fractions twice daily with 6 hours' gap, to a dose of 62.5 Gy/5 weeks pre-operatively or 75 Gy/6 weeks post-operatively. Fifteen tumours were situated in the thigh, eight in the lower leg, two in the ankle/foot and one each in the knee, buttock, elbow and forearm. Twenty-three were high-grade, one intermediate and five low-grade. Mean tumour size was 13 cm. Fourteen patients were treated pre-operatively, 10 post-operatively and five without surgery. Only six patients had "adequate" surgical excision. 19/29 received 75 Gy, and only two patients have not completed the planned treatment due to severe acute effects. Only two patients had field length < 25 cm and four were >40 cm. At a median follow-up of 1 year 18/29 are disease free, seven have died, four are alive with disease. There has been one local failure. Peak early reactions (Grade 3) occurred at about 5 weeks but occasionally persisted to 9 weeks. Although too early for full assessment of late damage there have been four wound breakdowns requiring surgical intervention, and the indications are that 75 Gy/60 fractions produce greater late damage in soft tissue than 60 Gy/30 fractions.

Tumour size as a prognosis factor in carcinoma of cervix: assessment by transrectal ultrasound (TRUS)

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Transrectal Ultrasound (TRUS) was used to measure tumour size in patients with carcinoma of the cervix, and to assess its prognostic significance. All patients were conventionally staged and at the time of EUA TRUS was conducted by an independent assessor; the tumour maximum transverse diameter was recorded. All patients were treated by radiotherapy; clinical management was not influenced by TRUS findings. Eighty-one patients were studied. F. I. G. O. stages were: IB 34 patients, IIA 7, IIB 31, IIA 2 and IIIB 7 patients. Mean tumour size by stage were: IB 37 mm, IIA 37 mm, IIB 49 mm, IIIA 42 mm, IIIB 50 mm. There was a significant

correlation between size and stage (p = 0.0001). With a median follow-up of 18 months, there have been 16 relapses. The relapse rates by stage were: IB 10%, IIA 17%, IIB 22%, IIIA 0%, IIIB 35%, (p = N.S.). There was however, a significant difference in relapse rate by size. At median follow-up, the relapse rates for the size groupings were: <30 mm, 0%; >30<40 mm, 11%; >40<50, 22%; >50, 38% (p = 0.03). Despite the small number of patients and short follow-up, tumour size as measured by TRUS appears to predict relapse. We are now comparing clinical staging, TRUS and MRI.

Comparison of the Ho's and the UICC/AJC stage classifications for NPC

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From 1985 to 1987, 570 nasopharyngeal carcinomas (NPC) were treated with radical radiotherapy. They were prospectively staged according to the Ho's classification. However, on presentation, the size, number, mobility and laterality of the cervical lymph nodal metastases were recorded and from this computer database, accurate retrospective staging according to both the UICC and the AJC classifications was possible. The UICC and the AJC classifications are identical in the overall staging for each patient, and they were considered together and compared with the Ho's classification. The Ho's classification is superior to the UICC/AJC classifications in predicting prognosis and it has a more even distribution of numbers of patients among the stages. There have been highly significant differences in the actuarial survival (ASR), disease-free survival (DFS) and actuarial free-from-distant-metastasis rate (DM) among the Ho's stages but not among the UICC/AJC stages. In the UICC/AJC classifications, over 400 patients fell into Stage IV, which included N2 and N3, T4 and M1, as if they shared the same prognosis. A significant difference in prognosis among these subgroups has been demonstrated, however, in the present study. Concerning tumours confined to the nasopharynx, those involving one site had a local recurrence rate similar to those involving more than one site (UICC/AJC T1 vs T2). This justified the combination of the two into a single T-stage (Ho's T1).

Cranial nerve involvement by nasopharyngeal carcinoma: response to treatment and clinical significance

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The incidence of cranial nerve involvement in a group of 564 patients with nasopharyngeal carcinoma treated in the Prince of Wales Hospital was 12%. The fifth and sixth cranial nerves were the most commonly involved. Fifty-nine patients were evaluable for response of neurological deficit to radical radiotherapy to a dose equivalent to 60 Gy/24 fr/6 weeks. 44% (26/59) of the patients with cranial nerve involvement had complete neurological recovery at a median follow-up time of 18 months after radiotherapy. The cranial nerve response, however, was not a significant predictor of local tumour control. Sixteen of the 59 patients were also given neoadjuvant chemotherapy before radiotherapy, with two patients achieving complete neurological recovery before radiotherapy. The difference in the rate of recovery may be related to the duration of tumour involvement, which in turn is regarded as being related to the distance away from the nasopharynx. As a significant number recovered completely, the potential for recovery of such peripheral nerves is remarkable.

Concomitant chemo/radiotherapy for advanced carcinoma of the head and neck

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Twenty-two patients with advanced head and neck cancer received chemotherapy during the first week of irradiation. Seventeen had Stage IV disease; four Stage III; and one Stage II. Age ranged from 21–73 years (median 60). Tumours involved: oral cavity, six; nasopharynx, five; oropharynx, five; secondary node from unknown primary, three; hypopharynx, two; paranasal sinus, one. Radiotherapy was delivered as 2 Gy per day 5 days a week (total dose 50–70 Gy, mean 60 Gy). A continuous intravenous infusion of 5-fluorouracil, 1 g/m^2/24 h started 3 h prior to radiotherapy and continued for 5 days; mitomycin C 14 mg/m^2 was given IV on Day 3. Chemotherapy was well tolerated. Radiotherapy was interrupted in four patients owing to mucosal reaction. Three patients did not receive the dose of radiotherapy intended; one developed necrosis of the hard palate (since healed), one a severe mucositis, and one known to have alcoholic cirrhosis developed a neutropenic infection and died of tumour haemorrhage. One other episode of neutropenic infection occurred. All five patients with nasopharyngeal carcinoma are disease-free. The 17 other patients have an actuarial 2-year survival of 42% (25% disease-free survival). The combination of 5-fluorouracil and mitomycin with radiotherapy is well tolerated and requires further evaluation. We do not recommend its use for patients with abnormal liver function.

Odorous symptoms during irradiation of the olfactory system

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During irradiation of volumes which incorporate the olfactory system, a proportion of patients have complained of a pungent smell. A retrospective study was designed to determine the prevalence of this side-effect. A questionnaire about olfactory symptoms occurring during irradiation was sent to 40 patients whose treatment volumes included the olfactory area. A control group treated away from the head and neck region completed the same questionnaire. Twenty-five patients replied. The regions irradiated were: whole brain (four); pituitary fossa/suprasella (eight); nasopharynx (seven); maxillary antrum (six) and frontal lobe (one). Overall, 60% of patients experienced odorous symptoms during irradiation. The greatest proportion occurred in patients receiving irradiation to the whole brain (75%) and nasopharynx (71%). None of the controls experienced odour. Their description of the odour was unpleasant and consistent with ozone. The radiochemical formation of ozone is well established and its stimulation of the irradiated olfactory receptors in animals has previously been described, but this side-effect of irradiation in humans is apparently not documented. We suggest that patients administered irradiation to volumes which include the olfactory sensory system should be forewarned and reassured before odorous symptoms occur.

Notes

Bramham Suite

Oncology (9.00–10.15)

The diagnosis of soft tissue sarcomas by CT and NMR

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Soft tissue sarcomas are rare tumours accounting for less than 1% of all malignant tumours. The principal treatment is surgical resection, but chemotherapy and radiotherapy play an important role. These treatment regimes require precise delineation of tumour extent, and until recently CT has been the mainstay of radiological staging. MRI provides excellent soft tissue contrast as well as multiplanar images, and both of these facilities are a major advantage in the evaluation of soft tissue sarcomas. We have undertaken MR examinations in 82 patients with soft tissue sarcomas in an attempt to evaluate its role in management at the time of diagnosis, during follow-up and when relapse is suspected. The majority of our patients also underwent CT examinations for comparative purposes. Overall our results have shown that MR delineates tumour extent more precisely than CT, but in the group of patients studied pre-operatively there was no significant difference between the two techniques with regard to the presence or absence of neurovascular invasion, adjacent muscle involvement or attachment to skin. CT demonstrates cortical bone erosion better than MR. In evaluation of post-operative patients MR not only shows reduction in tumour size more precisely than CT, but may also reveal changes in signal intensity within the mass. MR and CT are probably equally accurate in the detection of recurrent disease, although the high contrast between tumour and adjacent muscle on T_2-weighted images gives a higher credibility to magnetic resonance imaging.

Notes

Clinical applications of SPECT with special reference to Oncology

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Recently developments in equipment and radiopharmaceuticals have occurred which have greatly enhanced the value of SPECT in clinical practice. The result has been a great improvement in the clinical images from tomographic examinations which are now available in seconds after the acquisition has been completed. However, these results can only be obtained with the application of good quality control and the correct use of filters to match the clinical situation (Yanch et al, 1988). In the brain SPECT is used mainly for the study of perfusion using HM-PAO. The group at the Royal Marsden Hospital have documented the patterns of perfusion in brain tumours and the changes in perfusion of brain tumours as radiotherapy and chemotherapy produces a response (Babich et al, 1988). However, the perfusion pattern so far has not proved to be a good predictor of response to therapy.In the thyroid gland, SPECT has been used to provide data on radiation dosimetry to correlate the clinical effect of radioiodine therapy with the dose delivered (Webb et al, 1986). Results so far show that the optimum dose to render patients with thyrotoxicosis euthyroid within one year is about 50 Gray. A similar study of dosimetry in carcinoma of the thyroid should help to reduce unnecessary irradiation.In lung tumours perfusion studies with Tc99m HM-PAO have shown large areas with under perfusion which presumably influence the oxygenation and accessibility of chemotherapeutic agents explaining at least in part the poor response rates (Rowell et al,1989). Currently quantitative SPECT is being used to study the effect of vasoactive drugs on lung perfusion. Hydralazine has been shown to improve lung tumour perfusion by 30%. This may prove to be of value in improving the uptake of diagnostic and therapeutic agents. Studies with emission tomography and Gallium 67 are proving useful in the elucidation of masses near the hilum due to the lymphomas. This technique has proved to be particularly useful in evaluating masses seen on X ray after therapy. In the liver SPECT has improved the detection rate for space occupying lesions. It has been shown that improved contrast can be achieved by using 180 degree rotation centred around the right side of the patient (Ott et al, 1983). SPECT has proved useful for demonstrating the vascularity of haemangiomas - a difficult differential diagnosis for ultrasound where a single lesion can mimic early metastatic involvement. Parenchymal lesiosn of the kidney can be imaged more clearly using SPECT especially during and after infections. The results are complementary to ultrasound where scarring may be difficult to image. Although bone scintigraphy can detect abnormalities long before plain X rays, the use of SPECT can improve the visualisation of abnormalities especially in the deeper areas of the body. These include the lumbar spine, pelvis and maxillofacial region. Techniques where the lesion background ratio can be low such as in antibody imaging and white cell scintigraphy for infection can be greatly improved by using SPECT. Lesions which are barely visible on planar imaging can be seen clearly on the SPECT study. Similarly in miBG studies the lesions are more obvious using SPECT and in addition radiation dosimetry studies can be performed more accurately predicting which tumours are likely to respond to radioiodine therapy (Hinton et al, 1987).

References

Babich, J. W., Keeling, F., Flower, M. A., Whitton, A., Fielding, S., Fullbrook, A., Ott, R. J. & McCready, V. R., 1988. *Nuclear Medicine, 14* ,39-44.

Hinton, P. J., Fielding, S. L., Moyes, J. ,Meller, S. T. & McCready, V. R., 1987. *Proceedings of the European Association of Nuclear Medicine Congress, Budapest.*

Ott, R. J., Flower, M. A., Khan, O., Kalarai, T., Webb, S., Leach, M. O. & McCready, V. R., 1983. A comparison between 180° and 360° data reconstruction in single photon emission computed tomography of the liver and spleen. *British Journal of Radiology, 56*, 931–937.

Rowell, N. P., McCready, V. R., Tait, D., Flower, M. A., Cronin, B., Adams, G. E. & Horwich, A., 1989. *British Journal of Cancer, 59*, 135–141.

Webb, S., Flower, M. A., Ott, R. J., Broderick, M. D., Long, A. P., Sutton, B. & McCready, V. R., 1986. Single photon emission computed tomography imaging and volume estimation of the thyroid using a fan-beam geometry. *British Journal of Radiology, 59*, 951–955.

Yanch, J.C., Irvine, A.T., Webb, S. & Flower, M. A., 1988. Deconvolution of emission tomographic data: a clinical evaluation. *British Journal of Radiology, 61*, 221–225.

Comparison of CT and MRI in Ewing's sarcoma

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A prospective comparison was made of the CT and MR examinations of 11 patients with Ewing's sarcoma. Eight patients subsequently underwent surgery and this histology was correlated with the diagnostic imaging. One patient had further surgery for suspected recurrence. Sites of disease were rib (three), pelvis (three), tibia (three) and humerus (two). Assessments were made: pre-treatment (five), during/after treatment (11), pre-operatively (six), pre-operatively MR only (two). We assessed the extent of soft tissue and marrow disease, the relationship of disease to the joint/epiphyseal plate, the presence of cortical breakthrough and response to treatment. There was

concordance between the two techniques in: 57% (soft tissue disease), 50% (marrow disease), 50% (relationship to joint), 100% (cortical breakthrough), 75% (response to treatment). Histological correlation showed MR to be superior to CT in assessing relationship of tumour to joint (50%). CT and MR both overestimated the extent of soft tissue and marrow disease in one patient each. High signal on T_2-weighted images did not always indicate active disease. We conclude that MRI is better than CT for the assessment of the relationship of tumour to adjacent joint. Very high signal on T_2-weighted images is often due to necrosis or it may be due to vascular new bone formation. CT and MR may overestimate soft tissue and marrow disease.

Wilms' tumour; what changes are seen on CT following chemotherapy?

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Aim. Pre-operative chemotherapy is used in this institution for all patients with inoperable, and some with large, Wilms' tumours (WT) to improve surgical operability and morbidity. The CT appearances of chemotherapy-induced changes in WT have not been described. We have analysed CT examinations of children undergoing preoperative chemotherapy to assess the effects of treatment. *Method.* Enhanced abdominal CTs of 18 patients (aged 11 months–9 years) performed at presentation and following a course of chemotherapy, were reviewed. Disease was staged, tumour appearances were documented and comparison made with surgical and pathological findings at delayed operation. *Results.* Tumour size reduction of 52–99% occurred in 17/18 patients. Poor clinical response to chemotherapy occurred in one child, where the tumour size decreased by only 26%. Disease relapse was associated with an 84% increase in tumour size in one patient. Cystic changes developed in 14/18 tumours and increased calcification in 11/18. Radiologically assessed tumour stage reduced in 13 patients following chemotherapy, in most cases due to regression of hepatic involvement by the tumour. The accuracy of radiological and surgical staging is compared. *Conclusion.* This study demonstrates reduction of tumour size and radiologically-assessed disease stage in the majority of patients undergoing preoperative chemotherapy, and confirms the potential benefits to the surgical management of WT.

Inguinal and iliac lymph node involvement in germ cell tumours of the testis. Implications for radiological investigation and for therapy

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Inguinal or pelvic lymph node metastases are an uncommon manifestation of testicular germ cell tumours (TGCT). They are said to occur in patients with disruption of the normal lymphatic pathways due to previous scrotal surgery or local tumour extension, or as a result of retrograde spread from large para-aortic masses. Inguinal or pelvic metastases are of importance because routine CT scanning in patients with testicular tumours does not always include these regions, and because the need for routine treatment to the pelvic and inguinal nodes has been questioned in some patients. On review of the case notes of 1191 patients with TGCT seen at the Royal Marsden Hospital between 1977 and 1989, 22 were found who had developed inguinal (11) or pelvic node (11) metastases. Six patients had a history of maldescent and orchidopexy and one patient had congenitally fused testes. Of the remaining 15 patients, eight had bulky para-aortic metastases (5 cm or more in diameter), two had histological evidence of breach of the tunical vaginalis by tumour and in five patients no predisposing cause was found. Inguinal or iliac metastases were significantly more common in patients with either previous orchidopexy or bulky para-aortic disease ($p = 0.00004$). Patients with a history of maldescent or congenital anomalies of the genitourinary system, or with bulky para-aortic disease, should routinely have the pelvis and inguinal regions included on a CT scan, and patients with a history of maldescent may be unsuitable for local treatments that do not include these areas.

Thin-slice computed tomography for assessment of tumours and responses to therapy

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The main use of CT in oncology is in tumour detection, and typical procedures involve scans stepping through an appreciable longitudinal distance, using relatively thick (*e.g.* 10 mm) slices. Another useful role is in assessing tumours pre- and post-therapy and, to judge from the current literature on this subject, it is common practice to use the same "thick slice" scanning procedure for this as for tumour detection. Here we show that CT can offer the best possible assessment if the tumour is covered by a set of thin (*e.g.* 2.4 mm) contiguous slices and, so long as the approximate location is already known, it is practical and cost-effective to do this. Elementary geometry and clinical examples show that even for tumours of dimensions up to 2–3 cm, thick-slice scanning may give uncertain estimates of tumour dimensions and even erroneous conclusions about post-therapy changes. In contrast, a stack of thin contiguous slices gives much better delineation not only of tumour margins but also of internal inhomogeneity, and the evaluation is less subject to positional reproducibility problems which can affect serial comparisons. Aside from the clinical examples, a simulation experiment is described which suggests that the post-therapy response of a circumscribed lung mass at a known location could be followed down to 1 mm diameter and early regrowth could be readily detected and quantified. In our experience, it is essential to use a dedicated technique for tumour assessment rather than techniques which have evolved for detection. It offers a better physical characterization (of tumour dimensions and macroscopic structure) with considerable potential for illuminating questions about tumour responses, regrowth and even physical inhomogeneity.

Paratesticular RI abdomyosarcoma: radiological appearances of patterns of disease, presentation and relapse

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We present the radiological patterns of disease presentation and relapse in 17 patients with paratesticular rhabdomyosarcoma, who presented to the Royal Marsden Hospital between 1979 and 1989 (age range 9–42 years, mean 18 years). Stages at presentation (RMH/Barts staging system) were: Stage I, 13 patients; Stage II, three patients; Stage III, one patient. All patients had baseline and follow-up CT examinations of the thorax, abdomen and pelvis, with lymphangiography in some to further investigate small volume nodal disease. Of the patients with Stage I disease, six relapsed, with five developing low-density para-aortic nodal masses; two of these patients had Stage III disease at relapse, with liver metastases, and one of these also had pulmonary metastases. The remaining patient developed pelvic nodal disease. At presentation, the three patients with Stage II disease demonstrated para-aortic metastases only. One progressed to develop posterior mediastinal disease with extradural cord compression, retroperitoneal deposits (a nodule behind the left kidney) and ascites. Another died with recurrent pelvic disease. The patient with Stage III disease at presentation had lytic bone deposits, marrow, liver and para-aortic involvement.

Ultrasound examination of regional lymph nodes: value in staging and follow-up of malignant melanoma

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Early diagnosis and therapy of regional lymph node metastases are extremely valuable for staging and follow-up of malignant melanoma. We analysed 141 examinations of 100 patients with malignant melanoma using a 5 MHz linear array. The sonographic findings were confirmed either histologically (39 cases) or by the course of disease (88 cases). Fourteen patients were lost to follow-up. As our study shows, ultrasound, with a sensitivity of 95%, is more sensitive than palpation (sensitivity of 78%), whereas palpation has a higher specificity (96%) than ultrasonography (88%). The nearly pathognomonic sonographic appearance of melanoma metastases (round or oval, sharply demarcated, hypoechoic) is demonstrated. Examples of diagnostic pitfalls are given as well. Due to the high sensitivity, ultrasound should be used in melanoma patients pre-therapeutically, regularly in the follow-up and in case of non-diagnostic palpation, *e.g.* due to scar tissue after lymphadenectomy or irradiation.

Endocrine Studies (10.45–12.00)

Endocrine tumour localization

S. McEwan
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Abstract not received.

Computed tomography in phaeochromocytoma

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Phaeochromocytoma is an uncommon cause of hypertension, but early detection is important as surgery may be curative and complications of the tumour may be fatal. CT scans of 48 patients with strong clinical and biochemical evidence of phaeochromocytoma and a mass on CT were reviewed. Full clinical details were available in 38 patients, 34 of whom had surgery: 32 had phaeochromocytoma, and 2 benign cortical adenoma. The majority of patients had a long history of symptoms suggestive of phaeochromocytoma before the diagnosis was considered (average duration 91 weeks). Seven presented acutely (two cerebro-vascular event, one retinal artery occlusion, two malignant hypertension, one post-operative hypertension, one haematuria); five developed hypertension during pregnancy and four were diagnosed after routine medical examinations. Five patients had associated conditions (2 MEA Type II, 2 neurofibromatosis, one von Hippel-Lindau syndrome). CT demonstrated two bilateral adrenal phaeochromocytomas, 32 unilateral adrenal tumours and 10 ectopic tumours (six abdominal, one bladder, three thoracic). Two ectopic tumours (one thoracic, one bladder) were not detected by CT because the regions were not scanned. Tumours were generally large (mean maximum diameter 4.5 cm), of mixed (20) or homogeneous (24) attenuation with contrast enhancement (35/39), particularly of the periphery, some with central cystic components. Three were malignant phaeochromocytomas (1 skeletal metastasis on CT, 1 nodal metastasis not detected on CT). Of 35 patients in whom the clinical outcome after surgery was known, 23 were cured, with resolution of hypertension. CT is a quick and sensitive method for the detection of adrenal and most abdominal phaeochromocytomas, when appropriate scanning protocols are used. Other ectopic or multiple tumours can be difficult to detect, and MIBG scanning and venous sampling are important adjuncts for tumour localization.

The elusive upper parathyroid adenoma on thallium-201/technetium-99m subtraction scintigraphy

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A consecutive series of 50 patients with a total of 51 surgically resected and histologically proven parathyroid adenomas was analysed to determine the sensitivity and predictive value of $^{201}Tl/^{99}Tc^{m}$ scintigraphy in pre-operative localization of the tumour. Twenty-four adenomas were accurately located with respect to their precise anatomical positions: an overall sensitivity of 47%. The sensitivities of precise localization of the upper, lower and ectopic adenomas were 24%, 71% and 60%, respectively. The overall predictive value of precise localization was 71%; the predictive values of positive scans indicating upper and ectopic adenomas were both 100%, although the numbers were small. For scans suggesting lower adenomas, the predictive value was 60%. The overall sensitivity of unilateral localization was 66% (right side 70%, left 56%) with a predictive value of positive scans of 92%. Our results indicate that whilst $^{201}Tl/^{99}Tc^{m}$ subtraction scintigraphy could be considered a reasonably accurate means of unilateral localization of a parathyroid adenoma, it is poor at detecting the precise anatomical location of the tumour. This is especially true for an upper adenoma. Two explanations for this are proposed. The upper adenoma prolapses inferiorly when pathologically enlarged, which may lead to scintigraphic misinterpretation of a lower lesion, and because of its deeper location, it is more difficult to detect.

Correlation of the ultrasound and histology of the scintigraphically hot thyroid nodule

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The ultrasound and histology of 40 patients with scintigraphic "hot" nodules was correlated to determine if "hot" nodules have diagnostic ultrasound appearances. Conventional thyroid imaging starts with scintigraphy which is sensitive but non-specific. We start with high-resolution ultrasound, followed by scintigraphy if indicated. Ultrasound examination was performed with a SDU 7000 7.5 mHz static B-scanner to produce multiple axial and sagittal images. Scintigraphy was performed using 2 mCi Tc pertechnetate. Histology was obtained either by aspiration or surgery. The results show that the ultrasonic appearances of "hot" nodules covers a wide spectrum. A significant number of scintigraphically solitary "hot" nodules are part of a multinodular pathology on ultrasound. The histology of "hot" nodules is varied. Thyroid ultrasound is very sensitive to parenchymal change and the images provide a wealth of information which currently remains difficult to correlate with function and histology. Scintigraphy is no longer a useful primary investigation.

High resolution CT of the pituitary in children with growth hormone deficiency

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The study was undertaken to assess whether structural abnormalities of the pituitary were present in children with idiopathic growth hormone deficiency (GHD). Fifty-two patients (25 boys and 27 girls), with an age range of 14 days to 15.5 years, were studied. High-resolution CT scans were performed using contiguous 1.5 mm slices through the sellar and suprasellar regions. From these data coronal and sagittal reformations were generated. Quantitative observations were made of pituitary and sella dimensions, and the integrity of the infundibulum was assessed. Structural abnormalities of the pituitary were demonstrated in almost half the patients (partially or completely empty sella, 24; attenuation in calibre or partial absence of the infundibulum, 30). In 26 patients for whom detailed clinical and biochemical information was available, there was a strong correlation between structural abnormalities (empty sella) and (1) perinatal adverse events ($p < 0.001$) and (2) multiple pituitary hormone deficiencies ($p = 0.014$). These results suggest that adverse perinatal events may cause vascular damage and ischaemia. This leads to structural damage to the pituitary gland and infundibulum with consequent growth hormone deficiency, or pan-hypopituitarism, particularly in those with a genetic predisposition to GHD.

Retroconversion of immature teratoma of the ovary: CT appearances

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Immature teratoma of the ovary is a rare tumour of germ cell origin which as a group constitutes less than 3% of all ovarian cancers, occurring primarily in children and women under 30. We have studied seven patients presenting to the Royal Marsden Hospital 1983–1989 with metastatic immature ovarian teratoma. All patients underwent initial surgery followed by combination chemotherapy and second-look laparotomy. Serial CT scans were performed at 3-monthly intervals until the second laparotomy, and the results were correlated with the CT appearances. Serum levels of the tumour marker alpha feto-protein (AFP) were also monitored. Before the onset of chemotherapy, CT revealed multiple, mainly low-attenuation, inhomogeneous soft-tissue masses, mostly within the pelvis but also in the abdomen in association with bowel loops, the mesentery and retroperitoneally. Within 3–4 months of the start of chemotherapy, dramatic CT changes were evident, with increasing density of these tumour masses, whose margins became better circumscribed, and they developed internal calcification, with areas of fatty density and cystic spaces. On histological examination following second-look laparotomy, these masses were found to represent mature teratoma, analogous to the commoner mature ovarian teratoma or "dermoid cyst". This phenomenon of so-called retroconversion of immature teratomatous deposits to mature disease following chemotherapy correlates exactly with normalization of the raised serum AFP levels seen initially in 6/7 patients. Slow continued growth of some of these mature deposits was seen, causing local pressure symptoms in some cases, but overall no histological relapse occurred in any patient, and all are in sustained remission, 1 to 5 years from diagnosis. Because of its rarity, there has been scanty documentation of this tumour, particularly in the radiological literature, and this is the first report of a series, showing CT evidence of retroconversion to benign pathology.

Low-field MRI in the management of high-volume testicular teratoma

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In patients with high-volume malignant teratoma there is frequently residual soft tissue following intensive chemotherapy. It is sometimes difficult to distinguish between remaining active disease and mature teratoma, as the appearances on CT are non-specific. We have attempted to evaluate MRI as an alternative, and to determine whether surgical excision can be avoided. Approximately 30 patients were imaged by a low-field resistive MR system in addition to the routine CT protocols. Studies were performed before, and at intervals during, treatment and the results compared with the eventual surgical findings. MRI offered additional information in only a few cases and is as yet unable to replace surgery. Since it is also unsuitable for imaging the lung fields, it cannot be recommended for routine use, but may be of value in those cases in which CT is equivocal.

Notes

Teach-in: Diagnosis of Head and Neck Disease (2.30–3.45)

CT of the head and neck

J. E. Gillespie and *A. Gholkar
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CT has come to be regarded as the examination of choice following initial plain radiography in the evaluation of neoplastic and traumatic abnormalities of the extra-cranial head and neck. CT allows the direct visualization of neoplastic mass lesions as well as areas of bone erosion while in cases of trauma, associated soft tissue injury can be assessed. The anatomical complexity of this region, however, demands careful pre-examination planning in order to derive the maximum amount of information possible. Decisions regarding slice width, image planes required (direct multiplane scanning or multiplanar reformatting), the need for intravenous contrast medium and its method of administration, dynamic data acquisition and scan technique factors all need to be made prior to the examination and tailored to the clinical situation. The CT approach to neoplastic and traumatic lesions affecting the head and neck is discussed, along with the normal and abnormal anatomy of this region.

Notes

Charter Suite

Radiotherapy Dose Distribution and Tumour Control Probability (9.00–12.00)

Determinants of control probability of experimental tumours

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Experimental tumours allow one to study the general mechanisms underlying the response of human tumours to therapy, to test specific hypotheses, and to investigate new methods of treatment. In general, they do not allow one to make predictions of the response of individual human tumours to therapy. The roles of the five R's of radiology — repair, reoxygenation, repopulation, radiosensitivity and reassortment — have all been studied in experimental tumours. For instance, it has been shown that reoxygenation is an important determinant of the response to fractionation, that there can be accelerated repopulation, that repair rates may be faster than those of normal tissues, that the underlying tumour cell survival characteristics are more like those of early-responding than late-responding tissues (high α/β ratio), and that inherent cellular radiosensitivity is correlated with tumour response to radiation. There are important differences between experimental and human tumours. Experimental tumours probably have a much higher clonogenic fraction than human tumours. They tend to have relatively high hypoxic fractions and grow much faster. Nevertheless, they will continue to be the testing system for new forms of treatment since if these do not work in the model systems, they will be unlikely to be of clinical value.

Dose response data for local tumour control

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Good clinical radiation dose–response data for local tumour control are extremely difficult to generate. In practice, doses are usually adjusted because of patient and/or tumour factors, and therefore reported dose variations, and their effect on outcome, must be very carefully examined. The same bias must be considered when data from many different series are amassed in an attempt to produce evidence of a dose response. Very few clinical trials have incorporated a randomization to different radiation dose levels. However, there is information of this sort for non-oatcell carcinoma of lung, carcinoma of bladder and carcinoma of the head and neck region, and these are reviewed. Other data purporting to provide dose-response information are critically assessed. The influence of the selection of clinical endpoints on the interpretation of the available data is discussed. The clinical significance of the shape of the response curve for tumour control is discussed, together with the relevance of the corresponding normal tissue dose-response curves, in terms of optimizing patient treatments.

The radiosensitivity of human tumour cells

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It is now well established that human tumour cells differ in radiosensitivity. The differences exist in the clinically-important low-dose region up to around 2 Gy. Irradiation at low dose rate amplifies these differences. At low dose rates the less sensitive tumour cells become much more resistant and their cell survival curves become almost straight. A large amount of data has been accumulated on the radiosensitivity of human tumour cells at a dose rate of around 2 cGy/min. This is argued to be the most clinically-relevant dose rate at which to determine radiosensitivity, both fore brachytherapy and for fractionated radiotherapy. Radiosensitivity appears to correlate with clinical response to radiotherapy. Current mathematical models of radiation cell killing allow components to be identified: a linear (*i.e.* exponential, "α-component") and a bending component ("β-component"). At low dose rate, and in the low-dose region of the acute-radiation survival curve, it is the linear component that dominates. The current position is set out, in an attempt to explain the differences in radiosensitivity among human tumour cells.

Influence of dose distribution on local tumour control probability

A. E. Nahum

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Recent advances in radiobiology have indicated that the cells in human tumours can be characterized by fairly well-defined values of the radiosensitivity parameter: α. This makes it possible to perform calculations of the number of surviving clonogenic cells, n_s, after a course of fractionated radiotherapy according to $n_s = n_o \exp(-\alpha D)$ where n_o is the initial number of clonogenic cells and D is the total dose. If one assumes that local control is achieved when no single clonogenic cell survives then the tumour control probability, TCP, will be given by $TCP = \exp(-n_s)$. Using a value of 0.35 for α (corresponding to a surviving fraction after 2 Gy of 0.50) derived from radiobiological data for human bladder tumour cells, a clonogenic cell density of 10^7 per cm^3, a clinically realistic mean tumour volume of 250 cm^3, and a 64 Gy tumour dose, the TCP comes out at 0.50 which is consistent with the observed clinical outcome. However, a very steep slope for the TCP vs dose curve is predicted. By assuming an inter-patient variation in α, normally distributed with $\sigma_\alpha = 0.08$, a clinically realistic slope is obtained. Modern treatment planning systems allow one to compute the dose distribution throughout the 3-dimensional tumour volume. One can thus quantify the effect of non-uniformities in the dose distribution, *e.g.* caused by a lack of beam flatness, hot and cold spots, conformal planning etc, on the expected TCP. The results of such a study for bladder cancer treatments will be reported on. The effect of non-uniform doses in targeted therapy with ^{131}I has also been analysed, revealing that TCP depends critically on tumour size.

Notes

Quantitative Bone Studies (2.30–3.45)

Bone densitometry

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The introduction and development of photon absorptiometry has enabled accurate bone mass measurements to become available in routine clinical use. With this technique a highly collimated beam of photons is obtained from an isotope source and the transmitted beam intensity is monitored with a well-collimated scintillation detection scheme. The use of beams of known unique photon energies, together with energy selective detection, produces a very stable and therefore precise measurement system. Single photon absorptiometry is generally used to obtain measurements of the forearm, and with the introduction of dual photon absorptiometry it is possible to measure bone mass in both spine and femur, correcting for the variable amounts of soft tissue present. Over the past 2 years dual-energy X-ray absorptiometry has become available and seems set to become the gold standard for bone mineral measurements for the foreseeable future. This latest development in absorptiometry uses an X-ray tube rather than an isotope source to produce a higher photon flux. Thus scan times are speeded up considerably and image resolution and measurement precision are also much improved.

Quantitative bone mass measurement: techniques and correlations

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Single photon absorptiometry (SPA) was introduced about 20 years ago and provides measures of cortical and integral (cortical and trabecular) bone mineral density (BMD) in various sites of the forearm. Dual-energy photon absorptiometry (DPA) came later and provides measures of integral bone mass in the lumbar spine and femoral neck, with corrections for fat and soft tissue. More recently, dual energy X-ray absorptiometry (DEXA) has been developed, in which X rays are used in place of the gadolinium radionuclide source of DPA, with resulting improved precision and faster scanning time. Quantitative CT is also an established technique for the measurement of bone mass and uniquely permits the separate assessment of cortical and trabecular bone, and is generally applied to the lumbar vertebrae. We have studied 64 patients with a variety of metabolic bone disease who have had bone mass measurements made using SPA, QCT and DXA. Correlations have been sought between different sites (DEXA femoral neck vs. DEXA spine, $r = 0.632$; DEXA spine vs. QCT, $r = 0.76$; DEXA femoral neck vs. QCT, $r = 0.629$; DEXA spine vs. SPA, $r = 0.491$) and the results confirm that measurement of BMD at a certain skeletal site by one technique cannot usefully predict the BMD elsewhere, made by the same or a different technique in the same individual. The different methods are therefore complementary, rather than competitive, in the study of bone mass and the effects of disease on the skeleton.

Notes

Dual energy quantitative computed tomography (DEQCT) for measurement of vertebral trabecular bone composition

R. W. Whitehouse and J. E. Adams
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Single energy QCT is an established method for measuring vertebral trabecular bone density, but may underestimate the mineral content due to the effect of marrow fat. DEQCT can produce fat-corrected trabecular bone mineral estimates and has greater accuracy than single energy QCT, though poorer precision. The difference between single and dual-energy QCT estimates of bone mineral density is related to marrow composition, particularly fat content, but may also be influenced by increase in soft tissue components of bone, such as unmineralized osteoid in osteomalacia. DEQCT mineral estimates using the method of Genant and Boyd (1977) have been calculated in 54 "normal" patients with no evidence of metabolic bone disease and with normal bone mineral density as measured by SEQCT. Estimation of marrow composition was made from the difference (Δ) between single and dual energy QCT. These data have been compared with those of patients with asymptomatic primary hyperparathyroidism (161), Cushing's syndrome (19) and osteomalacia (14). The data from the normal patients and those with hyperparathyroidism demonstrate an increasing difference (Δ) with age, paralleling the age-related increase in yellow marrow fat content. Patients with Cushing's syndrome show greater difference values (Δ), from normal patients of the same age, suggesting increased marrow fat. Patients with osteomalacia show a decreased difference (Δ), reflecting the presence of unmineralized osteoid. DEQCT may provide information on the quantitative composition of trabecular bone in groups of patients with diseases affecting the skeleton.

An *in vitro* study of ultrasonic attenuation in bone

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The technique of Broadband Ultrasonic Attenuation (BUA) measurement of the os calcis as a means of diagnosing osteoporosis was introduced by Langton. In this study, we have investigated the factors affecting the reproducibility and accuracy of the technique and have studied the relative contribution of the attenuation of the constituent materials and the bone architecture. The study demonstrates that reducing the frequency range of the measurements from 200–600 kHz as used by the commercial system, to 400–600 kHz, improves the reproducibility significantly. The coefficient of variation of measurements *in vitro* over a 2-day period was changed from 1.17% to 0.76% by restricting the bandwidth in this way. At 1 mHz, attenuation measurements on collagen, fat and hydroxyapatite have been performed. These show attenuation values of 0.62, 0.60 and 8.0 dB/cm/MHz respectively as compared with a value of roughly 30dB/cm/MHz for cancellous bone *in vitro*. 500 kHz data is currently being acquired but the early indications are that a roughly linear relationship with frequency exists. Thus it seems clear that bone attenuation is dominated not by the nature of its constituents but rather by the internal geometry. The clinical implications of this finding are discussed.

Notes

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