MEDICAL PRACTICE

Occasional Review

The diagnostic process: a comparison of scanning techniques

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In choosing between various scanning techniques the factors to be considered include availability, cost, the type of equipment, the expertise of the medical and technical staff, and the inherent capabilities of the system. Although it is difficult to state dogmatically which scanning technique is best for each patient and condition, one or other technique is clearly preferable in some areas of medicine. Ultrasound, for example, should be used in obstetrics, while computerised tomography has revolutionised neuroradiological diagnosis. Nevertheless, there is still no substitute for good history taking and a thorough physical examination. The most important factor determining the choice of technique is the system's ability to answer the specific question required for the management of the patient.

Introduction

The use of the newer scanning procedures will undoubtedly have an important influence on the diagnosis and management of patients in hospital practice in the next decade. It is, of course, impossible to be dogmatic about which of these diagnostic modes should be used in a particular patient with a given

condition. But certain general principles and guidelines have already emerged. We outline here some of the factors that should be considered in choosing between ultrasonography and computerised tomography (CT).

Computerised tomography v ultrasound

Cost—The equipment needed for performing CT costs about 10 times as much as ultrasound equipment, as does its repair and maintenance. But if developments in ultrasound imaging include automation and computer analysis, then this gap will narrow.

Training of personnel—Both techniques require trained technical and medical staff. The training for ultrasonography probably takes twice or three times as long as that for CT, especially for the radiologist. The quality of the information produced in ultrasonography depends much more on individual ability than does that provided by CT, even though "grey-scale" ultrasonic displays are more easily recognised in terms of anatomy than the previous "bistable" black and white pictures.

Anatomical display—Anatomically and diagnostically the crux of the matter is that CT produces images that are much clearer as anatomical sections and can be recognised as such without too much difficulty, whereas even the best ultrasonic images require explanation and guidance for untrained doctors. Some ultrasonographers may consider this an advantage as it makes the referring physician or surgeon dependent on the radiologist. Nevertheless, this does not overcome the fundamental difference that CT pictures, with their more objective anatomical display, are easier to interpret than ultrasonic images.

CLEAR-CUT SUPERIORITY

In some areas of medicine one or other of these techniques is quite clearly preferable, irrespective of cost.

Obstetrics—Because CT uses ionising radiation it is contraindicated in pregnant women. Ultrasonography, on the other hand, is ideally suited to obstetrics and has no known hazard for mother or fetus.

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Neuroradiology—Other than for detecting the midline, ultrasound plays no part in neuroradiological diagnosis. The fact that the images are open to misinterpretation and that findings are extremely observer dependent accounts for the limited use of ultrasonography in brain diagnoses. By contrast, CT has revolutionised neuroradiological diagnosis and in centres where it has become established has displaced conventional techniques such as air encephalography, angiography, and isotope scanning. The number of these examinations has fallen dramatically: isotope scanning of the brain has virtually been eliminated and the numbers of air encephalograms and cerebral angiograms have been cut by 80% and 60% respectively.¹

Thorax—Two other areas where CT is incomparable and ultrasound has no place are the diagnosis of lung disease and skeletal diagnosis. Ultrasound has made great strides in cardiology, not only in the diagnosis of pericardial effusion but also in the display and measurement of valvular and ventricular function,^{2,3} but the retrosternal region and mediastinum fall within the regions requiring CT.

In many areas of medicine, however, the use of these techniques is not clearly defined and there is disagreement about their respective merits.

ABDOMEN

Except in obstetrics, both methods are used in the abdomen with varying degrees of success. There appears to be most rivalry between the two techniques in the liver and pancreas. Deciding which scanning technique to use is, however, a medical problem and not a commercial competition. The facts, where available, must be given without prejudice and the patient's welfare must be our overriding concern.

Pancreas—At Northwick Park Hospital and the Clinical Research Centre we have found that in about 20% of cases, in spite of patient preparation, there is too much bowel gas for ultrasonography to be successful in examining the pancreas. In the remaining cases ultrasound and CT produce similar results. Both methods can detect tumours and cysts greater than 3 cm in size and distinguish between them. Difficulties in examination and interpretation arise with both techniques, particularly in the region of the tail of the pancreas.

Liver—Ultrasonography is very efficient for imaging the liver and gall bladder, though there is again a small failure rate owing to the bowel gas problems. Ultrasound can resolve the normal intrahepatic vascular structures and is proving reliable for detecting metastases and other focal disease. CT examination of the liver may be indicated when ultrasound is not available or has failed, though its resolution in this region is currently inferior to that of ultrasound. Additionally, much of the liver may be included in the area examined by CT when the pancreas is being investigated and it is logical to extend the examination by a few extra cuts to survey the entire liver if metastatic disease is to be excluded.

Lymph nodes—In lymph node disease CT appears to be more accurate in defining the location and extent of the disease, particularly in the retrodiaphragmatic-paravertebral region from D 10 to L 1.

Abdominal aorta—In aortic disease, however, ultrasound gives more information, as longitudinal sections are possible and no intravenous contrast medium is needed to distinguish the vascular channel from surrounding blood clot.⁴

PELVIS

In the pelvis CT is particularly valuable in detecting lymph nodes, bladder tumours, spread of carcinoma of the cervix, and recurrence of colonic carcinoma. Ultrasound may also prove to be useful in these conditions, but the clarity of the total display on CT, including the bones, will probably be the overriding factor.

SUPRARENALS

The suprarenals need special consideration. Both the normal and abnormal suprarenal glands are so well shown by CT that when this is available it should be the method of choice. For Conn's syndrome, however, the display of a tumour is largely irrelevant. Active tumours are often bilateral and often less than 1 cm in diameter. Furthermore, a tumour may be present and yet completely inactive. The most important aspect of diagnosis in aldosteronism is venous sampling for localising activity. The same can be said for insulinomas in the pancreas. In the suprarenals, however, isotope scanning with iodo-

cholesterol seems to be effective in detecting some of these tumours. Otherwise CT is extremely valuable, especially in pheochromocytoma and Cushing's tumours of the suprarenal.

INCONGRUITY OF INFORMATION

Ultrasound and CT depend on quite different physical factors to produce their images. Ultrasound uses differences in acoustic impedance at interfaces, while CT measures differences in radiation attenuation. The resulting images are largely comparable, since both represent thin slices of the patient.

A solid tumour on CT and ultrasound appears as a denser soft-tissue lesion while a cyst returns no ultrasound echoes and has lower tissue attenuation coefficients on a CT image. There are, however, exceptions. Haemorrhage into a cyst or a localised collection of blood may appear echo free on ultrasound but on CT will be seen as an area of increased density. A lymph-node mass in lymphoma will be seen as an area of uniform low-amplitude echoes on ultrasound but will appear similar to other soft tissues on CT. Areas of calcification will return high-level echoes on ultrasound scanning and may cast acoustic shadows on single-pass scans, but on CT images they are clearly delineated around their entire circumference and produce no shadowing. As a last example, the intrahepatic portal veins and hepatic veins can be differentiated on ultrasound since portal veins return high-amplitude echoes from their walls, but on CT images both appear similar. Small areas of lower density taken to be veins within the liver substance on CT can be distinguished from each other only by their position.

FAT PLANES

For the adequate delineation of abdominal organs on CT fat planes must be present. It is often very difficult to outline the pancreas or retroperitoneal structures in chronic pancreatitis or other wasting disease because of the loss of adipose tissue. This is, however, no hindrance to ultrasound and is, in fact, an advantage, the abdominal organs being better displayed in thin patients. Gas accumulation, however, prevents satisfactory examination by ultrasound but not by CT. Very fat subjects show particularly well on CT but present problems in imaging with ultrasound.

RADIOTHERAPY AND TUMOUR MONITORING

In the abdomen there are at least two other factors to be considered. In terms of radiotherapy the exact position of the mass related to the skin and spine can be clearly shown in toto with CT, whereas it is difficult to achieve a complete axial display by ultrasound scanning.

In assessing tumour spread for staging malignant disease, CT has the great advantage of visualising bone and lung structures as well as the primary site of interest and without interference from overlying bowel gas. Thus CT is clearly preferable for planning radiation therapy and staging and monitoring patients with multifocal malignant disease. When radiation ports are to be planned for a single readily accessible area ultrasound may nevertheless be very useful and is adequate for monitoring the progress of focal disease outside the chest and skull.⁵

Isotope scanning

While ultrasound and CT have been compared and contrasted, isotope scanning must also be considered. Isotope scanning is acknowledged to be best suited to detecting pulmonary emboli and as a screening procedure for bone metastases, but it cannot compare with CT in brain diagnosis or with ultrasound and CT in the liver, pancreas, lymph nodes, or pelvis. By and large, isotope diagnosis is best when concerned with functional and physiological data, whereas CT and ultrasound produce better anatomical displays.

Diagnostic sequence

The past decade has seen an explosion of new diagnostic techniques, using endoscopy, double contrast, and various types of imaging. It is most important that these should be used intelligently to obtain information relevant to the patient's

management rather than to satisfy the curiosity of the doctor. It is not enough to undertake an examination in the vague hope of showing an abnormality. The investigator must ask a specific question relevant to the patient's condition and then decide which method is best suited to answering that question. The more specific the question asked, the more accurate and relevant the answer is likely to be. Scanning techniques can, by and large, not answer a question such as "Why so wan and pale, fair maid?" but can give an answer to, "What is the size, shape, and position of a mass in the pancreas and is it solid or cystic?"

Generally, a stepwise but methodical approach is preferable to a blunderbuss, all-or-none approach in diagnosis. Investigations should proceed from the least invasive or traumatic, the simplest, and the cheapest method to invasive, complicated, and more costly methods. But at the same time the total process of diagnosis proceeds from the general to the specific. It cannot be said too often or too forcefully that in the vast majority of cases most information relevant to the patient's illness is obtained through the history. The doctor who does not speak to his patients or relatives but relies on tests will often miss the diagnosis. The physical examination also cannot be ignored. It must also be remembered that most patients are never referred to hospital because their symptoms have disappeared

within two to three weeks of a visit to the primary physician.

Each test should be aimed at yielding a new type of information and not the same information displayed differently. A space-occupying lesion may appear the same on isotope scanning, ultrasound, or CT, but ultrasound and CT show whether it is solid or cystic. If it is solid only histology, by and large, will be sufficiently specific for a tissue diagnosis. Scanning procedures as yet cannot be used as a substitute for histology.

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Contemporary Themes

Individual response from a teaching area to "Fit for the Future"

Report of an independent working group in Newcastle upon Tyne

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The Court Committee has indicated urgent deficiencies in our services for children. Some of its proposed remedies have been widely misunderstood.¹ We therefore felt that it was important to explore, after informed discussion, the reactions of individuals, believing that these were at risk of being lost or distorted in representations from professional groups and official bodies.

We report the results of an individual approach made to all general practitioners, vocational trainees, clinical medical officers, health visitors, school nurses, paediatricians, paediatricians

in training, and social workers within the Newcastle Area, which is a single district teaching area with a population of 297 000.

Methods

All 53 general practices in the city were approached, and, with the exception of five practices who declined, a visit was made by two of us (CD, MAD) singly or together. This gave us an opportunity for informal discussion about the Court proposals. Each partner was left with a summary of those proposals most relevant to general practice, and a questionnaire that he was asked to return. The doctors in the five practices who declined to meet us were sent summaries and questionnaires by post.

Trainee general practitioners in the Newcastle Vocational Training Scheme meet weekly in separate year groups during their three years in the scheme. After varying amounts of discussion in year groups about the Court proposals, each trainee was given a handout about the report and asked to complete a questionnaire.

For clinical medical officers two alternative meetings were arranged with three of us (LL, MAD, CD). Summaries and questionnaires were distributed and sent by post to those who did not come to the meetings.

Two of us (MMD, AS) met health visitors in small groups for discussions, and they were given summaries and questionnaires; a similar approach was made to school nurses.

Questionnaires were sent to all paediatricians with sessions in Newcastle and two of us (JP, HS) met each individual to discuss his answers. For paediatricians in training two alternative meetings were arranged with two of us (CB, HS) to discuss the Court proposals and distribute summaries and questionnaires.

MEMBERS OF WORKING GROUP

Dr C J Bacon, first assistant, department of child health; Mrs M M Davidson, divisional nursing officer (community division); Dr M A P S Downham, lecturer in community paediatrics; Dr C K Drinkwater, senior lecturer in family and community medicine; Dr E Ellis, paediatrician (child development centre); Dr I M S Gillie, specialist in community medicine (child health); Dr E Hey, senior lecturer in child health; Miss M Higgs, social services principal assistant (health services); Dr L Lombard, senior medical officer (community child health services); Mr W Morgan, lecturer in medical sociology; Dr J M Parkin, reader in child health; Miss A Y Sanderson, area nurse (child health); Dr H Steiner, senior lecturer in child health; Professor J H Walker, head of department of family and community medicine; Mr W Walton, assistant director, department of education; and Professor J K G Webb, head of department of child health.