SINGLE-PHOTON-EMISSION COMPUTERISED TOMOGRAPHY COMPARED WITH PLANAR BONE SCAN TO ASSESS FEMORAL HEAD VASCULARITY

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We performed single-photon-emission CT (SPECT) and planar bone scans to assess femoral head vascularity in ten patients with displaced intracapsular hip fracture. The heads were labelled with tetracycline and after excision at hemiarthroplasty were assessed for tetracycline uptake distribution by fluorescence under UV light.

The four which had the greatest tetracycline uptake were normal on SPECT and planar imaging. In two cases the planar bone scans were normal although SPECT suggested avarcularity thus giving false-negative results. Surgeons should be aware of this; SPECT may prove to be a more accurate method of assessing vascularity of the femoral head in fractures of the femoral neck.

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There is controversy over the treatment of displaced intracapsular hip fractures (Nicoll 1963; Lu-Yao et al 1994). The two most commonly used methods are reduction and fixation and hemiarthroplasty. Mechanical failure, non-union and avarcularity are problems that may result in the need for revision surgery.

The failure rate of internal fixation has been reported as between 8% and 38% (Sikorski and Barrington 1981; Skinner et al 1989), but is most widely quoted as around 25%. Early failure is due to poor technique or poor mechanical strength of the bone and later failure to poor vascularity. Avascular necrosis (AVN) is a well-known long-term complication requiring revision surgery in many cases.

A method is needed of identifying before operation those femoral heads which are viable and therefore have a greater chance of successful healing. Imaging techniques such as planar isotope bone scans, MRI and CT have been generally disappointing in this respect (Stromqvist et al 1984; Alberts 1990; Speer et al 1990). Scintigraphy has been the most promising (Lausten et al 1992) and postoperative scans have been shown to correlate with the outcome of fixation to some extent (Stromqvist et al 1984).

Single-photon-emission CT (SPECT) has been used extensively to assess cerebral and myocardial vascularity (Holman and Tumeh 1990). Its use in quantitative bone scanning has been less extensive but studies appear to confirm it as reliable and reproducible for estimating 99mTc methylidiphosphonate (MDP) uptake by bone (Front et al 1989). Problems in imaging femoral heads due to artifacts from the bladder have been reported, but these may be overcome by data processing (Gillen et al 1988; Bunker et al 1990; O’Connor and Kelly 1990). SPECT produces a tomographic bone-scan image and is potentially more reliable than planar isotope scanning (Bellah et al 1991). Although the same basic technology is used, enhanced contrast is achieved by the removal of counts from overlying structures. It may offer a refinement in determining the vascularity of the femoral head before operation and therefore the relative risk of developing healing complications after fixation. It should then be possible to offer the most appropriate and cost-effective treatment for the fracture.

Tetracycline can be used to assess the blood supply to the femoral head (Stromqvist 1983). Uptake has previously been assessed microscopically, but we have found that macroscopic assessment is adequate to show the uptake distribution.

PATIENTS AND METHODS

We performed a standard planar bone scan and SPECT scan of the femoral heads of ten patients with displaced intracapsular hip fracture within 48 hours of admission to...
hospital. They were given 600 MBq $^{99m}$Tc MDP three hours before imaging. Scanning was done on a Siemens Diacam (Siemens, Bracknell, UK) with 5 mm slice reconstruction. Tetracycline (1 g intravenously) was given 12 to 24 hours before surgery for hemiarthroplasty. After operation the femoral head was retained and stored in 99% alcohol solution.

Each femoral head was mounted on a methylmethacrylate cement cylinder to allow fixation in a vice, and bisected in the coronal plane using a water-cooled band saw (0.2 mm cutting band); two 2 mm slices were cut in the same plane. One specimen had only one slice because of technical difficulties. Two additional femoral heads, which were not scanned or tetracycline labelled, were also sectioned and used as controls.

Each of the slices was placed in a petri dish lid, with the dish base placed on top to provide a transparent surface to trace the outline of the section. This was examined macroscopically under a UV light source. For each slice areas of fluorescence corresponding to areas of tetracycline uptake were plotted by two independent observers on to the petri-dish base using a marker pen. These tracings were photocopied to give a permanent image of the distribution of tetracycline uptake which was measured using a grid of 1 cm squares. The result was expressed as the proportion of squares containing any labelled area (Fig. 1).

The distribution of tetracycline uptake was compared with the SPECT and planar isotope images which were reported by an independent observer. A positive scan indicated avascularity of the femoral head, a negative scan a normal appearance.

**RESULTS**

The mean uptake distribution of all four readings for each slice (two for case 8) is shown in Figure 2, along with the planar scan and SPECT reports. Differences in uptake between the two slices were insignificant and did not alter the rank order; the readings for both observers were also similar (Fig. 3). Both controls were reported negative for tetracycline uptake. We were confident therefore that interobserver and specimen variation effects were minimal.

In two out of the ten cases (1 and 4), the planar scan was negative (normal) but SPECT clearly showed avascularity (positive). The distribution of tetracycline uptake for these
was in the mid-range. They can be considered as false-negative planar bone scans.

DISCUSSION

Data-processing techniques have allowed removal of bladder artifacts and improved the quality of SPECT images. The probable reason for the false-negative results of planar imaging is that the image consists of summated counts due to overlying and adjacent bone, particularly in displaced fractures. SPECT is able to remove these unwanted counts by taking a slice image. Coronal and sagittal image slices were more useful than transverse ones. Work is continuing to quantify bone SPECT images accurately.

SPECT performed before operation on all patients undergoing internal fixation of intracapsular fractures of the femoral neck may allow more accurate prediction of late failure. Surgeons should be aware that planar isotope bone scans for assessing the avascularity of the femoral head may give false-negative results, and SPECT should be used in its place when it is available.

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REFERENCES


