EVALUATION OF PAINFUL HIP ARTHROPLASTIES
ARE TECHNETIUM BONE SCANS NECESSARY?

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We reviewed the plain radiographs, bone scans and hip aspiration results of 54 patients with painful hip arthroplasties which had been explored surgically, to compare the results of the investigations with the operative findings.

For acetabular loosening, the sensitivity and specificity of bone scanning were 87% and 95%, with an accuracy of 90%; for serial plain radiography sensitivity was 95%, specificity 100% and accuracy 97%. For femoral component loosening, bone scan sensitivity was 85%, specificity 100% and accuracy 89%; the sensitivity of plain radiography was 100%, with specificity 92% and accuracy 98%.

Technetium bone scanning did not provide additional information with regard to loosening and is not necessary in the routine investigation of a painful hip arthroplasty. Serial plain radiography is the most effective method of detecting loosening, and bone scanning is useful only when radiography is inconclusive with regard to loosening or infection.

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There is no ideal method of evaluating a painful replacement arthroplasty. In some cases the history, physical examination and serial radiographs clearly show either loosening or infection, but in others these two causes cannot be differentiated. Such diagnoses as trochanteric bursitis, stress fracture or even spinal pathology are also possible. It is important to establish the cause of pain before starting treatment. Various imaging techniques have been used, including plain radiography, arthrography, technetium bone scanning (Miniaci et al 1990), and gallium (Merkel et al 1985) and indium-labelled leucocyte scanning (Johnson et al 1988). It is important to avoid the cost of unnecessary sophisticated tests.

Bone scanning is sensitive in detecting loosening and infection, but it is not specific (Weiss et al 1979; Rushton et al 1982; Schneider et al 1982). Arthrography, especially on the femoral side, has mixed results (O’Neil and Harris 1984; Capello et al 1985; Miniaci et al 1990). Sequential radiography is still the most accurate method of determining loosening (Tehranzadeh, Schneider and Freiberger 1981; O’Neil and Harris 1984; Aliabadi et al 1989; Miniaci et al 1990).

We aimed to define the role of three-phase technetium bone scanning in the evaluation of painful cemented total hip arthroplasties.

PATIENTS AND METHODS

We reviewed all patients from June 1989 to April 1991 who had had a replacement hip arthroplasty and a technetium bone scan, excluding those with a previous history of infection or a cementless arthroplasty. Of the 60 patients with 60 arthroplasties, one had had a bipolar hemiarthroplasty. Fifty-four hips had been surgically explored for suspected loosening or infection; the other six had not yet had surgery. There were 22 men and 32 women with an average age of 65 years (35 to 85). The average time from primary hip arthroplasty to bone scan was 120 months (10 to 204). Five hips had had more than one arthroplasty before the study period.

Bone scans. Three-phase bone scanning was performed by gamma camera using a low-energy all-purpose collimator, after the intravenous injection of 20 mCi of $^{99m}$Tc methylene diphosphonate. Dynamic flow studies were performed by scanning every three seconds for one minute. Blood pool studies were by a single static anterior view done immediately after the dynamic flow study. Delayed static images used anteroposterior views of the right and left hips two hours after the injection. Each of the blood flow, blood pool and delayed static images was graded on a scale of 0 to III, where zero represented the uptake of normal surrounding bone. Grade I was a mild

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increase, grade II a moderate increase, and grade III was intense uptake (Kantor et al 1990). The femoral component was considered in the seven zones described by Gruen, McNeice and Amstutz (1979) for the evaluation of plain radiography, and acetabular changes were recorded for the three zones of DeLee and Charnley (1976).

A prosthesis was defined as loose on the bone scan if there was a mild or moderate increase in uptake (grades I or II) in more than two zones or intense (grade III) uptake in at least one zone (Horoszowski et al 1980). Infection was diagnosed on the bone scan if there was increased vascularity, an expanded blood pool study and/or diffuse uptake in the femur or the acetabulum.

**Radiographs.** Sequential standard anteroposterior and lateral plain radiographs were reviewed for evidence of loosening. Acetabular radiolucencies were graded by the criteria of DeLee and Charnley and acetabular fixation by a modification of the criteria of Harris and Penenberg (1987), which included migration of the cup, fracture of the cement mantle, or a continuous radiolucent zone of 2 mm or more.

Femoral component radiolucency was assessed in the zones of Gruen et al (1979) and femoral fixation by a modification of the criteria of O’Neil and Harris (1984). Loosening was defined as migration, subsidence, radiolucency between the metal and cement, cement mantle fracture, or circumferential radioluency measuring at least 2 mm in one zone.

**Review method.** All bone scans and plain radiographs were reviewed for loosening or infection by one radiologist (RS) with no knowledge of the clinical diagnosis, who made an independent diagnosis of acetabular or femoral loosening and/or infection. The patients’ medical records were then reviewed and the reason for the bone scan was recorded. The findings at the revision operation and the results of intraoperative cultures were then compared with the radiologist’s diagnoses and the results of the preoperative aspirations.

**RESULTS**

Of the 54 hips, 43 were revised for loosening, ten for infection and one for chronic dislocation. In 30 hips, nine of them infected, both acetabular and femoral components were revised. The tenth infection was in a frail 88-year-old woman who was treated by debridement and antibiotics with retention of the components. In 16 hips,
only the femoral component was revised, and in six only the acetabular component. In the single case of recurrent dislocation, the components were stable, and the patient was treated by trochanteric advancement and capsular repair.

The infected hips could not be assessed by bone scanning for loosening, because there was a diffuse increase in uptake throughout. For 44 femoral and 43 acetabular components it was possible to assess the sensitivity (true positive/true positive + false negative), the specificity (true negative/true negative + false positive) and the accuracy (true negative + true positive/ all hips) of the diagnosis of loosening on plain radiographs alone and on bone scans (Tables I and II).

Our results show that both bone scanning and serial radiography were reasonably accurate in diagnosing loosening. Bone scanning was more accurate for femoral than for acetabular loosening. On the femoral side, bone scanning and radiography together gave 93% agreement (41 of 44 for loosening with a 95% confidence interval of 85% to 99%). In three cases false-negative bone scans were seen with true-positive radiographs. Two of these negative scans on the femoral side were associated with osteolytic regions which showed no increase or a minimal increase in scintigraphic activity. In the third case plain radiography showed femoral subidence but there was only a mild increase in scintigraphic activity. In five other hips there was no increase in scintigraphic activity about the femoral component; in each one of these, the component was found to be stable at revision surgery.

On the acetabular side the results from bone scanning and radiography agreed in 90% of cases of loosening (39 of 43 hips), with a 95% confidence interval of 78% to 96%. In four cases the scan showed either minimal or no increased activity on the acetabular side although there was obvious migration on the plain radiographs.

Individual review of all 54 cases showed that, as regards loosening alone, bone scanning had not given any information not already provided by plain radiography (Fig. 1). The diagnosis of infection was never made on plain radiographs, but was made in seven of the ten bone scans (30% failure).

Of the 54 hips, 51 (94%) had diagnostic aspirations before revision operations. These were positive in all ten of the cases later confirmed as infected, and negative in 39 of the 41 non-infected cases, with two dry taps. The organisms identified from the preoperative aspiration were the same as those from surgical specimens in all ten cases. Hip aspiration was thus shown to be very accurate in predicting infection.

DISCUSSION

The diagnosis of the cause of pain in a total hip replacement is simple when there is gross loosening or overt sepsis, such as a draining sinus, but in many cases the differential diagnosis is extensive. The review of adequate sequential plain radiography is reported to be the most accurate method for determining loosening (Reing, Richin and Kenmore 1979; O’Neil and Harris 1984; Aliabadi et al 1989), especially for femoral components, but the role of technetium scanning has not been well defined. There are no specific scintigraphic criteria for loosening (Weiss et al 1979; Jensen and Madsen 1990; Levitsky et al 1991).

Our review has shown that three-phase technetium bone scanning has a very limited role in the investigation of pain in a cemented total hip arthroplasty, and is not required in every case. In the 54 hips having revision surgery for loosening, dislocation or infection, bone scanning failed to provide any more information than plain radiography or hip aspiration.

Previous reports have recommended bone scanning for diagnosing infection (Weiss et al 1979; Rushon et al 1982), but in our small series the diagnosis was missed on the bone scan in three of the ten cases, while culture of aspirate was positive in all. Our results agree with those of Levitsky et al (1991) who reported a specificity of 96% for aspiration, and a sensitivity of only 33% for bone scanning with regard to infection. Phillips and Kattapuram (1983) reported a sensitivity of 88% and a specificity of 83% for preoperative aspirations, although other authors have described higher rates of false-negative and false-positive aspirations (Hunter and Dandy 1977; Reing et al 1979; O’Neil and Harris 1984; Johnson et al 1988).
plain radiography and hip aspiration. In general, if the plain radiographs do not show loosening, an aspiration is negative, and there is no increase in activity on a bone scan, then the hip arthroplasty is neither loose nor infected.

We have developed an algorithm for the investigation of a painful total hip arthroplasty (Fig. 2). The first step is a review of the whole sequence of plain radiographs. If these are consistent with loosening then aspiration is performed to try to rule out infection before revision surgery. If the radiographs show no evidence of loosening a bone scan is performed to exclude loosening, and an aspirate is examined if infection is suspected.

If the bone scan shows no areas of increased uptake it is reasonably certain that the prosthesis is not loose: other sources of pain such as trochanteric bursitis or spinal pathology should be considered. Any area of focal uptake requires close follow-up since this type of increase in scintigraphic activity could signify early loosening. A period of partial weight-bearing with crutches may help; if symptoms persist serial plain radiography and repeat bone scanning are recommended.

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REFERENCES


