Three-Phase Bone Scan and Indium White Blood Cell Scintigraphy Following Porous Coated Hip Arthroplasty: A Prospective Study of the Prosthetic Tip

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Although few reports address the use of three-phase bone scanning (TPBS) and ^{111}In-labeled white blood cell (In-WBC) scintigraphy in hip arthroplasty utilizing a porous coated prosthesis, the literature suggests that scintigraphic patterns in the uncomplicated patient may differ from that seen in the cemented prosthesis. In an attempt to determine the scintigraphic natural history, 25 uncomplicated porous coated hip arthroplasties in 21 patients were prospectively studied with serial TPBS and In-WBC at ~7 days, and at 3, 6, 12, 18, and 24 mo postoperatively. This report deals with findings related to the prosthetic tip. Only one of 136 flow studies were abnormal and only two of 136 blood-pool images demonstrated focally increased activity. All 25 prostheses (120 of 143 scans) demonstrated increased uptake on the bone phase images. The area about the tip was divided into three segments; increased uptake at 24 mo was noted in the medial, distal, and lateral segments in 16%, 72%, and 56% of prostheses, respectively. Twenty of 25 prostheses (82 of 142 scans) showed uptake on In-WBC scintigraphy, being noted in 48% of prostheses at 24 mo. We conclude that scintigraphic patterns in the uncomplicated patient with a porous coated prosthesis appear to differ from patterns described in cemented prostheses.

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Although the complications of prosthetic loosening and infection are uncommon following total hip arthroplasty, the definitive diagnosis of these entities may present a considerable challenge to the clinician. Radionuclide studies may be helpful and the scintigraphic patterns in complicated and uncomplicated cemented hip prostheses have been well described (*1–11*). With the development of porous coated prostheses implanted without cement, the method of prosthetic fixation has changed (*12*). The porous coating of the prosthesis allows ingrowth of bone and fibrous tissue into the prosthesis surface itself. This might be expected to cause increased uptake of bone avid isotopes allowing an altered scintigraphic appearance unrelated to the suspected complication. Unless these scintigraphic changes are known, errors in interpretation of radionuclide studies could occur.

In an attempt to establish the natural history of scintigraphic changes following uncomplicated porous coated hip arthroplasty (PCHA), patients were prospectively studied using serial three phase bone scans (TPBS) and indium-111- (^{111}In) labeled white blood cell (In-WBC) scintigraphy. This report describes the scintigraphic findings in 25 prostheses so studied and deals only with the tip of the prosthesis. The findings related to the acetabulum and trochanters will be reported separately.

METHODS

From January through October 1985, a prospective study was performed on patients undergoing total hip arthroplasty utilizing an uncemented porous coated prosthesis (PCA Total

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Hip System, Howmedica, Rutherford, NJ). Informed consent was obtained. All patients were studied with serial clinical evaluations, radiographs, three-phase bone scans, and ^{111}In-labeled white blood cell scintigraphy. No patient demonstrated any clinical evidence of infection or radiographic evidence of loosening. None had pain requiring the use of medication. The radionuclide studies were scheduled at 7 days and at 3, 6, 12, 18, and 24 mo postoperatively.

Imaging Technique

On the day of the study, blood was withdrawn and the patient's white blood cells were labeled with [^{111}In]oxine while the TPBS was being performed. Studies were performed on a General Electric 400-T, 400-ACT, or 535 gamma camera utilizing low- and medium-energy parallel hole collimators for the TPBS and In-WBC, respectively. TPBS images were acquired using a 20% window centered about the 140 keV peak as follows.

Flow. Ten millicuries (370 MBq) of technetium-99m methylene diphosphonate ([Tc]MDP) were injected in an antecubital vein using a bolus injection technique. Serial images were acquired over the anterior pelvis and proximal thigh every 3 to 4 sec for 30 sec.

Blood Pool. A blood-pool image over the anterior pelvis and proximal thigh was obtained ~5 min after radionuclide injection. This image was acquired for 700,000 to 1,000,000 counts depending on the size of the field of view. If a second image was required to image the entire field of view, the second image was acquired for the same length of time as the first image.

Bone. A bone phase image was obtained 2.5 to 3 hr following radionuclide injection. This was acquired for 750,000 to 1,000,000 counts depending on the camera used. If a second image was required to image the entire field of view, the second image was acquired for the same length of time as the first image. The bone phase image was obtained with the same camera as the blood-pool image.

In-WBC. Labeling was done using 300 μCi (11.1 MBq) of [^{111}In]oxine according to standard technique (*13*). Following completion of the TPBS the patient's ^{111}In-labeled WBC were injected intravenously. Images were obtained 18 to 24 hr later using a 20% window centered about the 245 keV peak and a 15% window asymmetrically placed about the 171 keV peak. Images were acquired for 200,000 to 500,000 counts (depending of the size of the field of view) or 20 min, whichever occurred first. The In-WBC image was obtained with the same camera as the TPBS to allow better localization of the prosthesis tip on the In-WBC image. Whenever a second image was required to image the entire field of view, that second image was acquired for the same length of time as the first image. Labeling efficiency was >90%. Cell viability was greater than 97% using the trypan blue exclusion test.

Interpretive Criteria

All images were evaluated according to the following criteria.

Flow. Blood flow was evaluated in the region of the prosthesis tip semi-arbitrarily from injection to 8 sec after peak iliac vessel activity. Background was defined as that activity occurring at the same time in the soft tissue of a similar region in the contralateral thigh. Peak activity in the contralateral iliac vessel was used as a reference point. Blood flow was grade 0 when no increased activity above background was detected, grade 1+ when activity was greater than background but less than the reference point, grade 2+ when activity was equal to the reference point, and grade 3+ when activity was greater than the reference point.

Blood Pool. Blood-pool activity was evaluated in the region

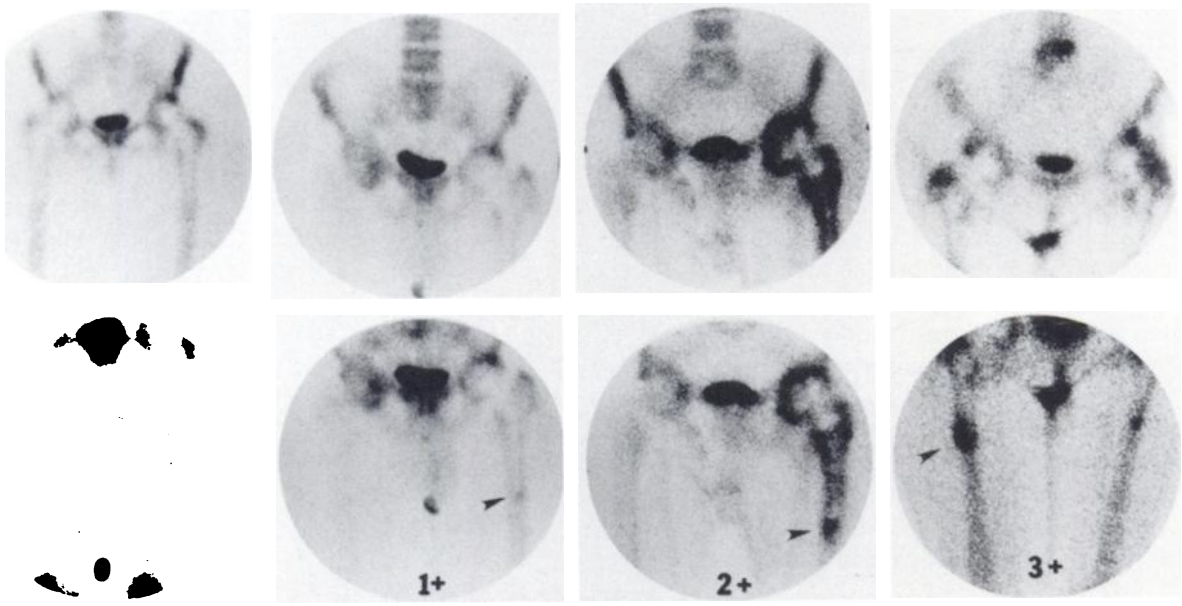

FIGURE 1
Examples of intensity grades (arrows) for bone phase images are shown. Images along the top row are views taken over the anterior pelvis so that comparison may be made with the ipsilateral iliac crest. Immediately below are images taken over the tip of the prosthesis in the same patient.

of the tip of the prosthesis. Background was defined as that activity occurring in the soft tissue of a similar region in the contralateral thigh. The contralateral iliac vessel was used as a reference point. Blood pool was grade 0 when no increased activity above background was detected, grade 1+ when activity was greater than background but less than the reference point, grade 2+ when activity was equal to the reference point, and grade 3+ when blood-pool activity was greater than the reference point.

Bone. The bone phase images were evaluated for intensity of uptake at the prosthetic tip. Background was defined as that uptake occurring in the contralateral femoral shaft or, in patients with bilateral prostheses, in the ipsilateral femoral shaft well distal to the prosthesis tip. The reference point used was the ipsilateral iliac crest. Grade 0 was assigned when there was no increased uptake above background, 1+ when uptake was greater than background but less than the reference point, 2+ when uptake was equal to the reference point, and 3+ when uptake was greater than the reference point (Fig. 1).

The tip of the prosthesis was arbitrarily divided into three segments: the medial segment, the distal segment, and the lateral segment (Fig. 2). Preferentially increased activity may be seen in each segment (Fig. 3). Intensity of bone uptake was recorded for each tip segment.

In-WBC. The In-WBC images were evaluated for multiple parameters.

Intensity of uptake. Background was defined as that uptake occurring in the contralateral femoral shaft or, in patients with bilateral prostheses, in the ipsilateral femoral shaft well distal to the prosthesis tip. The ipsilateral iliac crest was used as a reference point. Grade 0 indicated no increased uptake above background, grade 1+ indicated uptake greater than background but less than the reference point, grade 2+ was uptake equal to the reference point, and grade 3+ was uptake greater than the reference point (Fig. 4).

Pattern of activity. The size and configuration of activity present was noted.

Congruence of pattern. Defined as a subjective comparison of the size and configuration of tracer uptake in the area of interest on the In-WBC scan relative to the same area of interest on the bone phase images.

Analysis

Flow. No additional analysis performed.

Blood Pool. No additional analysis performed.

Bone. Following study completion, the bone phase images were analyzed for additional parameters:

Relative intensity between tip segments: The grade of intensity between segments was compared. This was done for each scanning time.

Trend in intensity: Each individual prosthesis was evaluated serially to detect any trend in changing intensity which might occur over time.

In-WBC. Following study completion, the In-WBC images were analyzed for additional parameters as follows:

(a) congruence of intensity: defined as a comparison of the grade of tracer uptake in the area of interest on the In-WBC study relative to the same area of interest on the bone phase image; (b) trend in intensity: each individual prosthesis was evaluated serially to detect any trend in changing intensity which might occur over time.

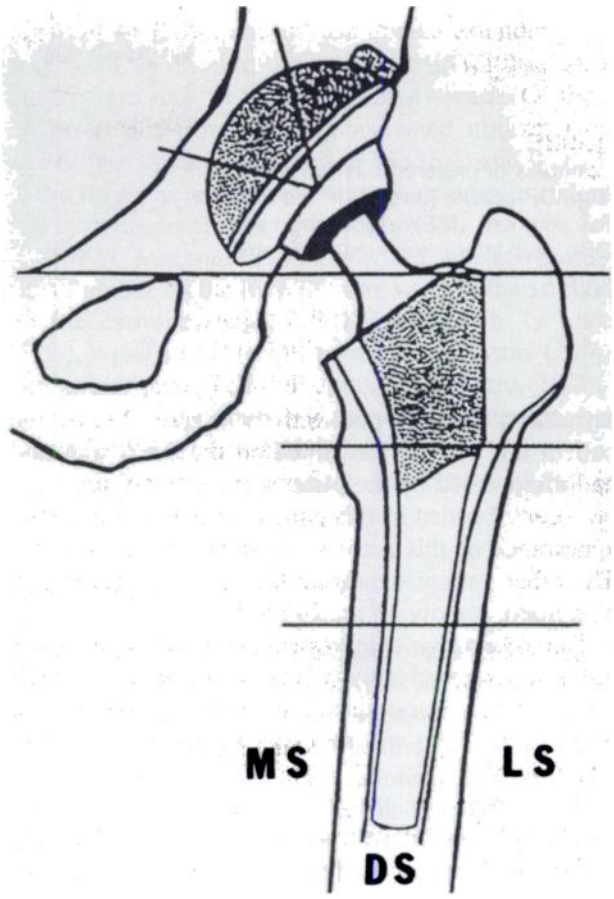

FIGURE 2
Schematic diagram of the porous coated hip prosthesis showing the three segments which describe the tip and the areas with porous surfacing (stippling). MS = medial segment; DS = distal segment; LS = lateral segment.

RESULTS

Twenty-five porous coated hip arthroplasties in 21 consecutive patients were studied. There were 14 males and seven females with a mean age of 62 yr (range 39 to 77 yr). Preoperative diagnoses included osteoarthritis in 19 patients, rheumatoid arthritis in one patient, and aseptic necrosis in one patient.

Flow. Of the 150 scheduled TPBS, 136 flow studies were technically adequate for interpretation. Only one flow study was abnormal, demonstrating very minimally increased blood flow in the approximate region of the tip of the prosthesis. This was seen on a scan obtained on the seventh day postoperatively and was not apparent on the 3-mo scan. The intensity of uptake was graded at 1+.

Blood Pool. Of the 150 scheduled TPBS, 136 studies were technically adequate for interpretation of blood-pool activity. There were two distinct types of increased blood-pool activity noted. The first was a focal increase in activity seen in the region of the tip of the prosthesis. This occurred in only two of 136 scans and was a subtle

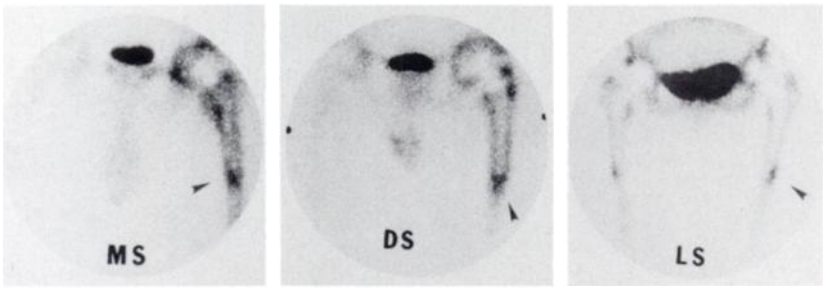

FIGURE 3
Examples of preferentially increased [Tc]MDP uptake (arrows) in the medial segment (MS), distal segment (DS), and lateral segment (LS) are shown.

asymmetry in blood-pool activity of grade 1+. In one patient this activity was noted on the 3-mo scan and had disappeared by the 6-mo scan. A 7-day scan had not been obtained in this patient so the time of initial appearance of this activity could not be ascertained. The other patient demonstrated focally increased 1+ blood-pool activity on the 24-mo scan.

The second type of increased blood-pool activity was diffusely increased activity seen throughout the entire thigh. This pattern occurred in 11 of 25 prostheses (20 of 136 scans) and was never seen prior to the 12-mo scan (Fig. 5).

Bone (frequency of uptake). Of the 150 scheduled TPBS, 143 bone phase images were adequate for evaluation. Technetium methylene diphosphonate (MDP) uptake was present at the tip in 84% (120 of 143) of scans and in 100% (25 of 25) of prostheses at sometime during the 24 mo of the study.

Bone (intensity grade). Of the 143 evaluable bone phase images, intensity of uptake was grade 0 in 23 scans (16%), grade 1+ in 64 scans (45%), grade 2+ in 40 scans (28%), and grade 3+ in 16 scans (11%). When considering the 25 prostheses as a group, intensity of uptake in the three tip segments can be appreciated for each scanning time by reviewing the corresponding graphs (Figs. 6, 7, 8).

Bone (relative intensity between tip segments). A comparison between the medial (MS) and lateral (LS) tip segments for each image revealed intensity of uptake in the MS less than the LS in 43 scans (30%), equal to the LS in 99 scans (69%), and greater than the LS in only one scan (1%). The medial-distal and distal-lateral comparison data were not believed to be clinically useful and are omitted.

Bone (trend in intensity). The data is shown in the corresponding graphs (Figs. 9, 10, 11).

In-WBC (frequency of uptake). Of the 150 scheduled In-WBC studies, 142 were adequate for interpretation. Of these, 60 (42%) showed no tracer uptake and 82 (58%) showed increased uptake at the tip of the prosthesis. Of the 25 prostheses studied, 5 (20%) showed no uptake, with the remaining 20 (80%) showing uptake at some time during the 24 mo of the study.

In-WBC (intensity grade). Of the 142 evaluable white blood cell scans, the intensity of uptake was grade 0 in 60 scans (42%), 1+ in 65 scans (46%), and 2+ in 17

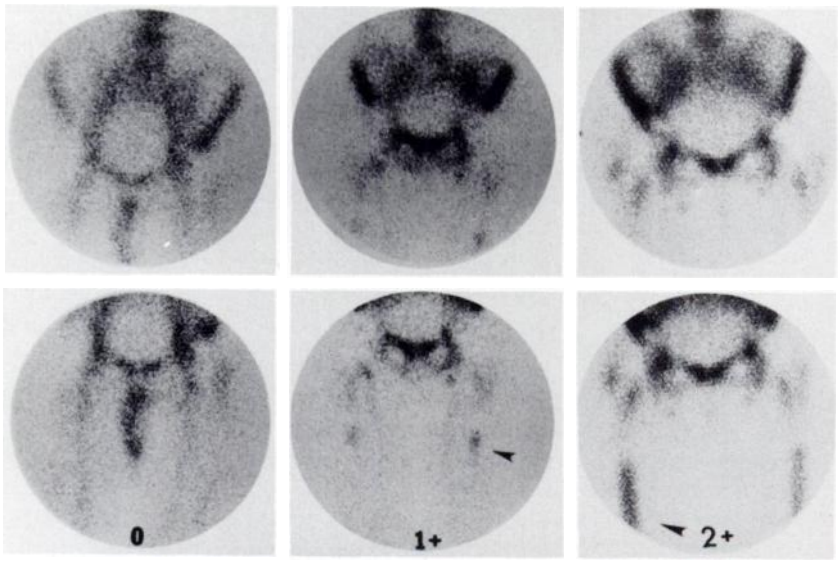

FIGURE 4
Examples of intensity grades (arrows) for In-WBC images are shown. Images along the top row are views taken over the anterior pelvis so that comparison may be made with the ipsilateral iliac crest. Immediately below are images taken over the tip of the prosthesis in the same patient. No patient exhibited grade 3+ intensity during the study.

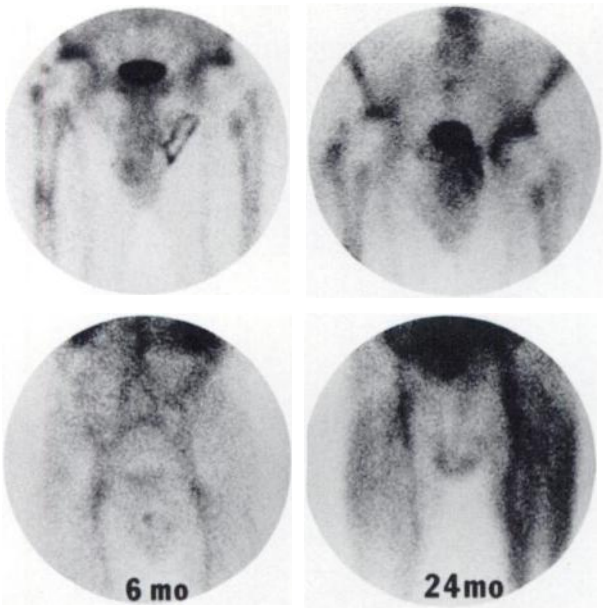

FIGURE 5
An example of diffusely increased blood-pool (BP) activity is shown. Along the top row are bone phase images over the tip of the prosthesis. The BP images on the bottom row demonstrate the development of diffusely increased unilateral BP activity in a single patient with bilateral arthroplasties.

scans (12%). No patient had grade 3+ uptake. Considering the 25 prostheses as a group, intensity of uptake at the tip for each scanning time is shown in Figure 12.

In-WBC (pattern of uptake). Two distinct patterns of activity occurred. Of the 82 scans with In-WBC uptake, focal accumulation of tracer at the prosthetic tip was noted in 41 (50%) and diffuse uptake extending in a linear pattern distal to the prosthetic tip (diffuse linear uptake) was seen in the remaining 41 scans. Of those 20 prostheses demonstrating increased uptake, focal and diffuse uptake was noted in 11 (55%) and 9 (45%) of the 20, respectively. Representative examples of these two patterns are shown in the Figure 13.

In-WBC (congruence of intensity). The relative intensity of uptake on the In-WBC scan was less than uptake on the corresponding [Tc]MDP images in 79 scans (57%), equal to [Tc]MDP uptake in 39 scans (28%), and greater than [Tc]MDP uptake in 21 scans (15%).

In-WBC (congruence of pattern). No congruence of pattern could be demonstrated.

In-WBC (trend in intensity). The data is shown in Figure 14.

DISCUSSION

The definitive diagnosis of infection or loosening in the patient with a painful hip prosthesis may be difficult and radionuclide evaluation is often helpful. While the radionuclide findings for cemented prostheses have been described for the complications of loosening and infection (*1–4,6–11*), as well as for the uncomplicated patient (*5*), no prospective study of scintigraphic findings in uncomplicated patients with porous coated prostheses has been reported to our knowledge. Since the method of fixation is different for the porous coated prosthesis, the scintigraphic findings in the uncomplicated patient might also be expected to be different. There are few reports in the literature, however, addressing this point.

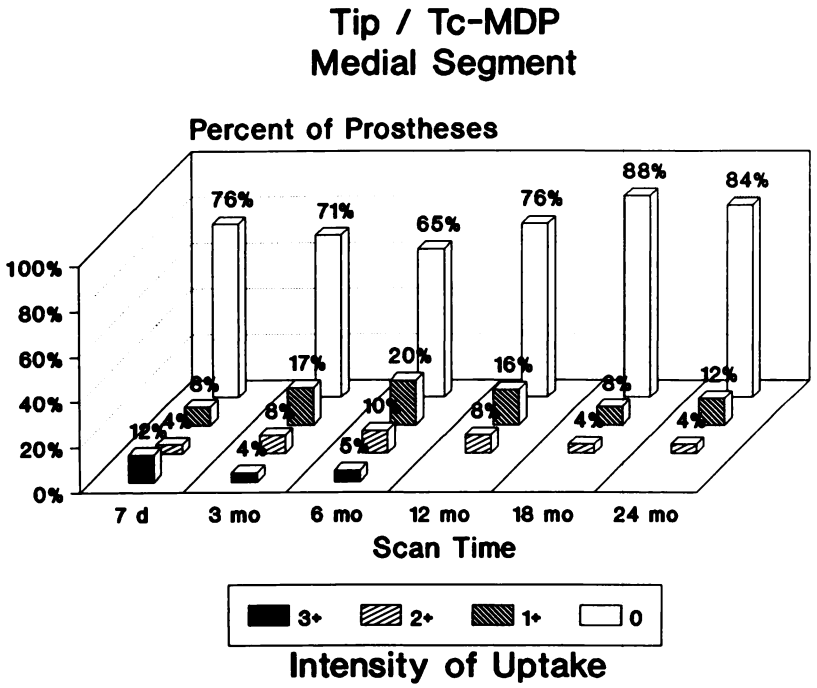

FIGURE 6
Considering the 25 prostheses as a group, the graph shows the percentage of prostheses demonstrating a given intensity of [Tc]MDP uptake in the medial segment of the tip at the various scanning times.

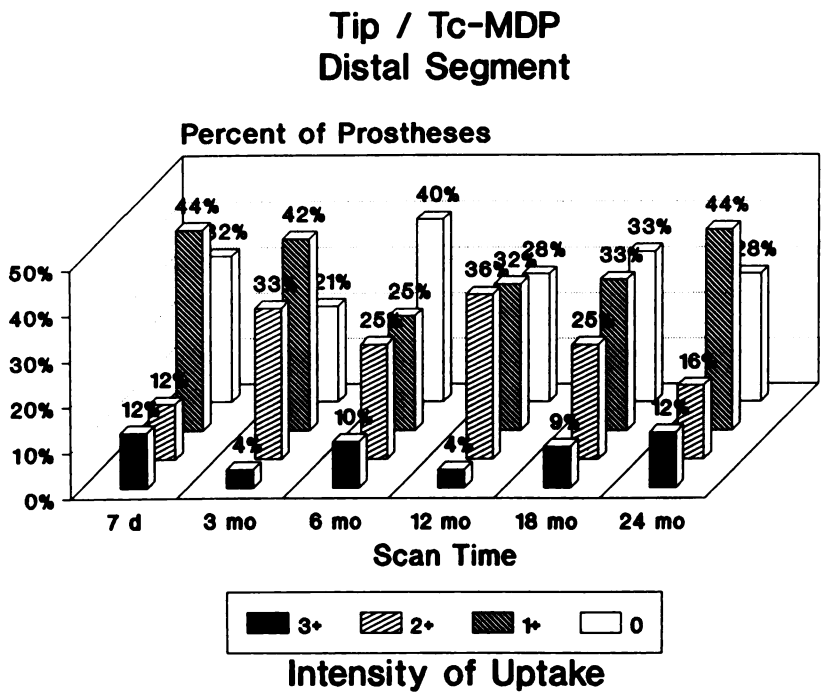

FIGURE 7
Considering the 25 prostheses as a group, the graph shows the percentage of prostheses demonstrating a given intensity of [Tc]MDP uptake in the distal segment of the tip at the various scanning times.

Amstutz (*14*) reported on 58 patients undergoing 62 hip arthroplasties using a porous surfaced prosthesis. Although he did not specifically address activity at the prosthetic tip, he reported increased activity on technetium diphosphonate bone scan at 2 yr. This was believed to be a result of continued remodeling of bone at the bone-prosthesis interface. Schicha (*15*), reporting on 69 porous coated arthroplasties in 61 uncomplicated patients, found that 74% of patients had increased uptake at the tip of the prosthesis on bone scintigraphy at 22 mo. However, not all patients had multiple scans performed during the study interval. This increased activity at the tip was not representative of prosthetic loosening. In a report of two cases of cementless prostheses by Higgins (*16*), one of which was a hip prosthesis, increased activity at the tip of the prosthesis on bone scan was noted 14 mo postoperatively. Neither infection nor loosening was present in this patient.

This report of a systematic, prospective evaluation of 25 porous coated prostheses with [Tc]MDP and In-WBC scintigraphy is an attempt to better define the natural history of scintigraphic changes in the uncom-

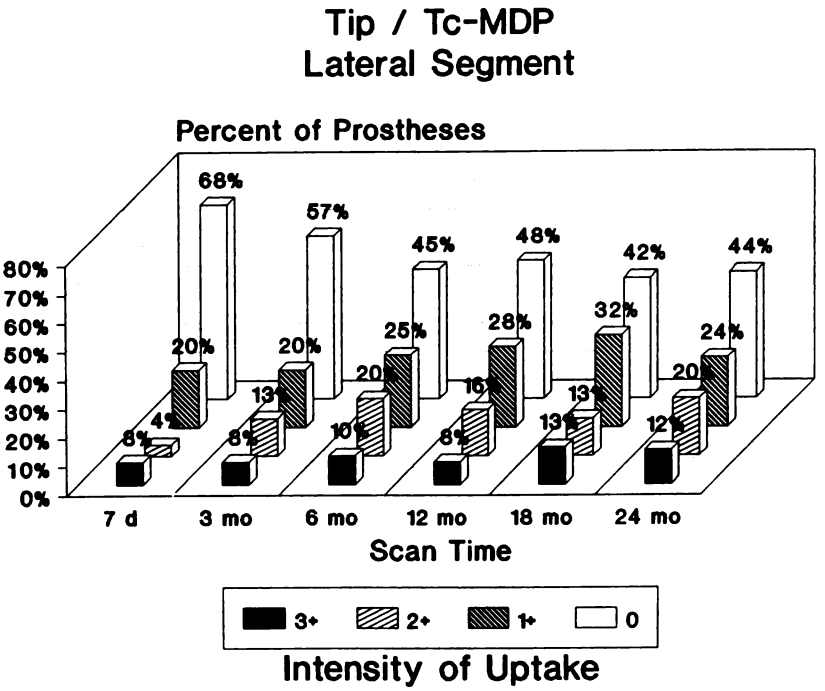

FIGURE 8
Considering the 25 prostheses as a group, the graph shows the percentage of prostheses demonstrating a given intensity of [Tc]MDP uptake in the lateral segment of the tip at the various scanning times.

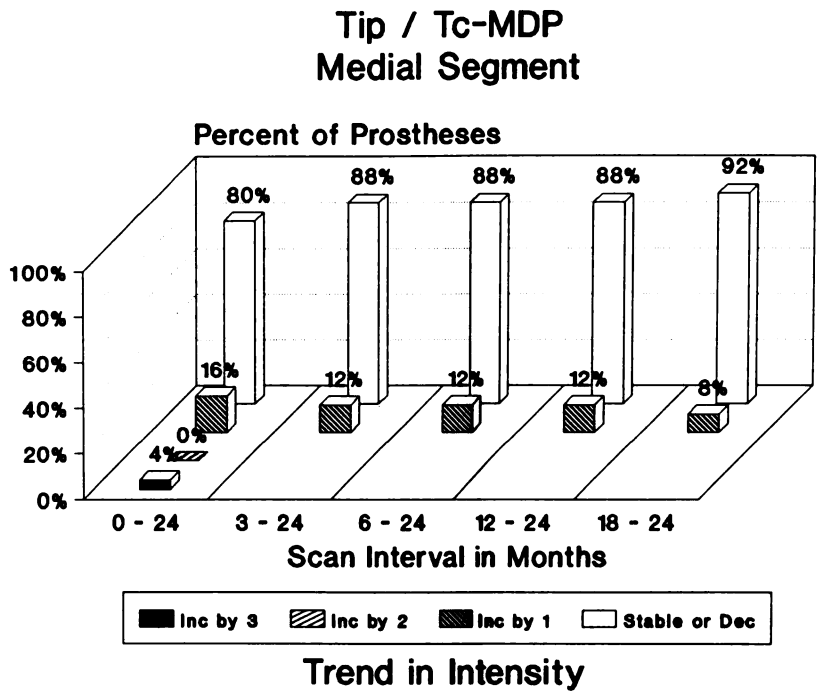

FIGURE 9
The graph shows the percentage of prostheses demonstrating a trend in changing [Tc]MDP intensity in the medial segment of the tip for a given time interval. For example, during the interval encompassing 3 to 24 mo postoperatively, 88% of prostheses exhibited stable or decreasing activity and 12% manifest increasing intensity by one grade.

plicated patient. We believe this data is of value in establishing the "normal" pattern of activity in these patients, providing a standard by which patients with a suspected complication may be compared.

An unexpected finding was that increased blood flow or focal blood-pool activity was rarely demonstrated. However, diffusely increased blood-pool activity throughout the muscles of the entire thigh was more commonly seen. In some patients this activity persisted once it appeared, however, in other patients its presence was intermittent. One patient with bilateral prostheses demonstrated diffuse muscle activity in only one thigh. We postulate that this diffusely increased activity may be the result of increased muscle usage in patients who were previously less active.

Unlike the flow or blood-pool portions of the TPBS, the bone phase images demonstrated the universal presence of [Tc]MDP uptake at the tip of each prosthesis at some time during the 24 mo of study. This implies that the presence or absence of uptake alone is of no clinical value in diagnosing infection or loosening. In order to determine whether any other parameters may

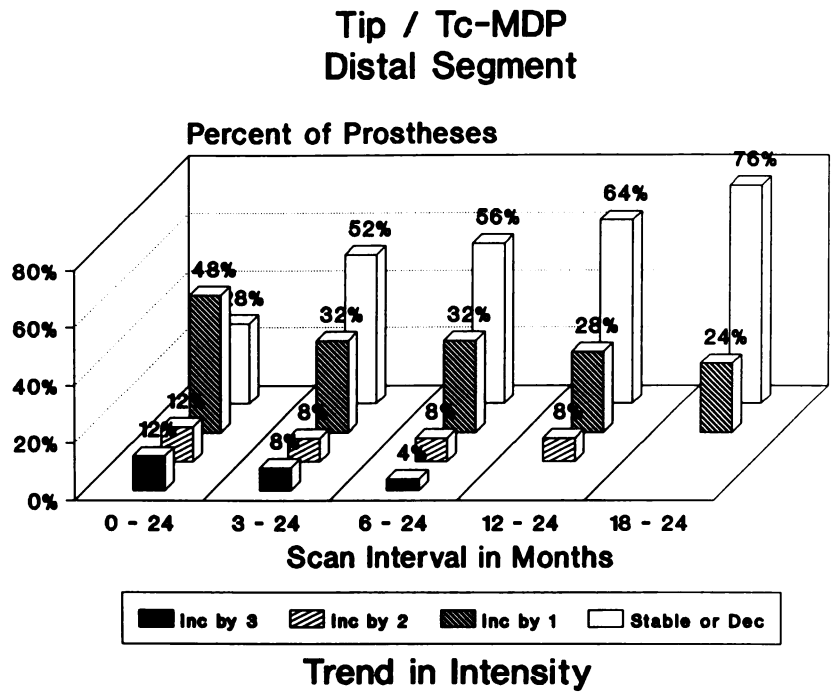

FIGURE 10
The graph shows the percentage of prostheses demonstrating a trend in changing [Tc]MDP intensity in the distal segment of the tip for a given time interval. For example, during the interval encompassing 3 to 24 mo postoperatively, 52% of prostheses exhibited stable or decreasing activity, 32% showed an increase by 1 intensity grade, and 8% each demonstrated increases by two and three intensity grades.

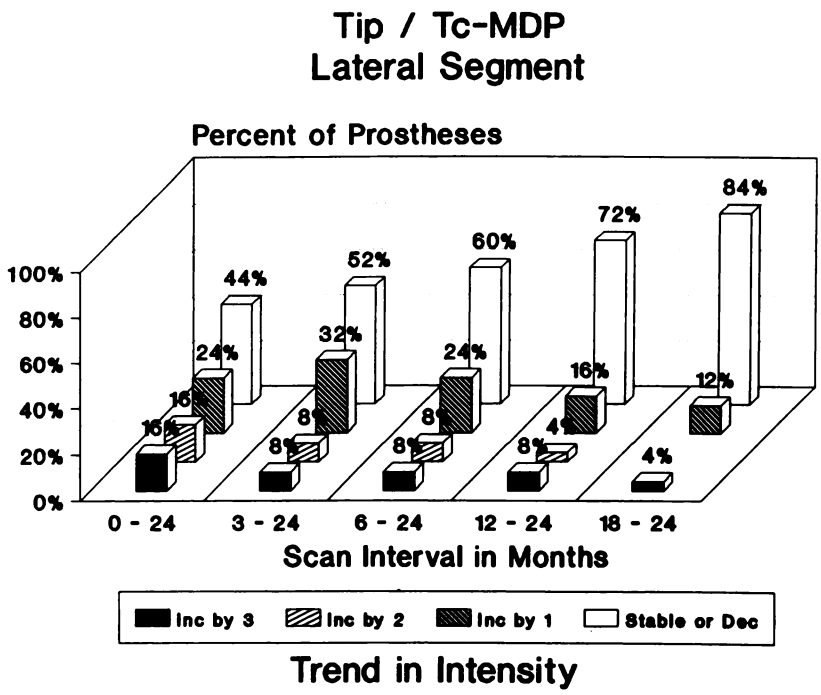

FIGURE 11
The graph shows the percentage of prostheses demonstrating a trend in changing [Tc]MDP intensity in the lateral segment of the tip for a given time interval. For example, during the interval encompassing 6 to 24 mo postoperatively, 60% of prostheses exhibited stable or decreasing activity, 24% showed an increase in intensity by one grade, and 8% each demonstrated increases by two and three intensity grades.

be of clinical utility to the imager in discriminating normal activity from a complication, we attempted to better characterize the activity at the tip.

When the 25 prostheses were considered as a group, analysis of the medial segment of the prosthetic tip revealed little to no activity at any given scanning time for the majority of prostheses (Fig. 6). The findings in the distal and lateral segments were very different (Figs. 7 and 8). In fact, the percentage of prostheses showing [Tc]MDP uptake in the lateral segment increased over time. Therefore, the presence of 2+ or greater activity in the distal or lateral tip segments, even 24 mo postoperatively, may not necessarily be representative of a complication. When comparison was made between tip segments in individual prostheses, with but one exception, activity in the medial segment was always less than or equal to lateral segment activity for any given scanning time.

Analysis of intensity over time for each individual prosthesis demonstrated a clear trend toward stable or decreasing activity within the medial segment (Fig. 9). A similar, although less striking, trend could be seen in the distal and lateral segments. However, during the 12- to 24-mo study interval, a number of prostheses exhibited increasing intensity of [Tc]MDP uptake by one or more grades in the distal (Fig. 10) and lateral segments

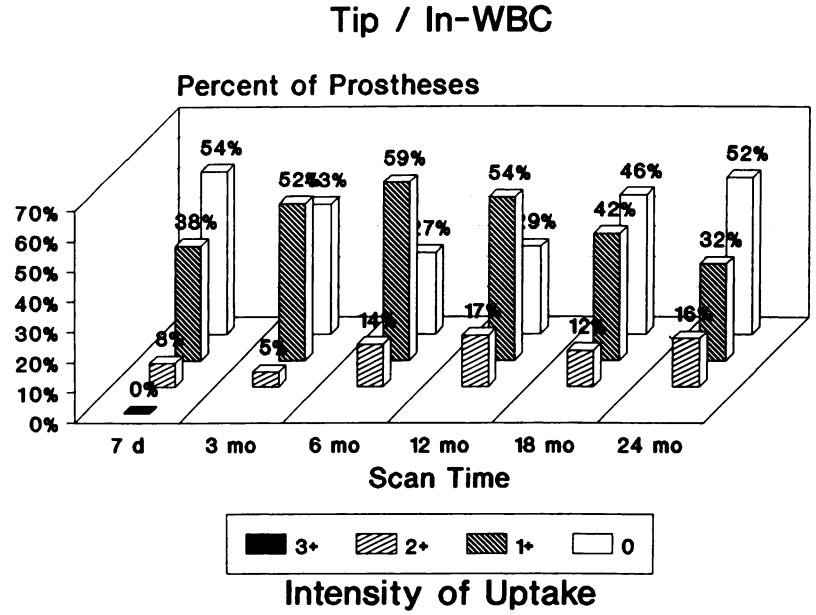

FIGURE 12
The graph shows the percentage of prostheses demonstrating a given intensity of In-WBC uptake at the tip at various scanning times.

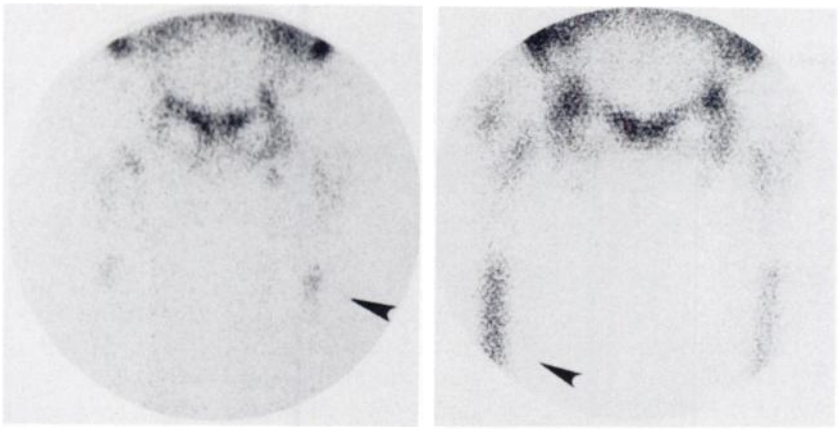

FIGURE 13
The images demonstrate the patterns of In-WBC uptake seen. The image on the left demonstrates focal uptake at the tips of bilateral prostheses. The image on the right shows diffuse linear uptake at the tips of bilateral prostheses.

(Fig. 11). This implies that even relatively late increasing activity in the distal or lateral segments may not be representative of infection or loosening.

If the criteria of stable or decreasing activity is used as evidence against the existence of a complication, then a baseline study is useful. To determine the optimal time to perform a baseline scan, the graphs (Figs. 9, 10, 11) are a useful guide.

Since no porous surface covers the tip of the prostheses in this study, the explanation for any significant [Tc]MDP uptake must be sought elsewhere. We believe that tip activity occurs as a result of micro-motion at the tip of the cementless fixation as previously described (*17*). This may account for the persistent and sometimes increasing activity seen in some patients.

Although a number of papers have reported on the use of In-WBC imaging in patients with painful or infected prostheses (*3,4,6,8–11*), the prospective use of In-WBC studies in the uncomplicated patient has not, to our knowledge, been reported. In-WBC uptake was present at the tip in 80% of prostheses at some time during our study and in 58% of scans. Therefore, the mere presence of In-WBC uptake does not necessarily indicate infection.

Two distinct patterns of In-WBC uptake were seen: focal and diffuse linear. These occurred with approximately equal frequency. Since In-WBC uptake is normally seen in bone marrow, the focal uptake at the tip may represent normal marrow (*6,10,18*) and should not be construed as representing infection. It is more difficult to explain the diffuse linear In-WBC uptake extending distally from the tip. Seven of the nine prostheses exhibiting this pattern of activity did so with the first scan. This diffuse linear activity persisted throughout the entire length of the study in seven prostheses and, in a single patient with bilateral arthroplasties, the activity subsided at 12 and 18 mo, respectively. Further investigation of this observation, possibly with sulfur colloid marrow imaging, may be helpful.

Analysis of In-WBC intensity over time for each

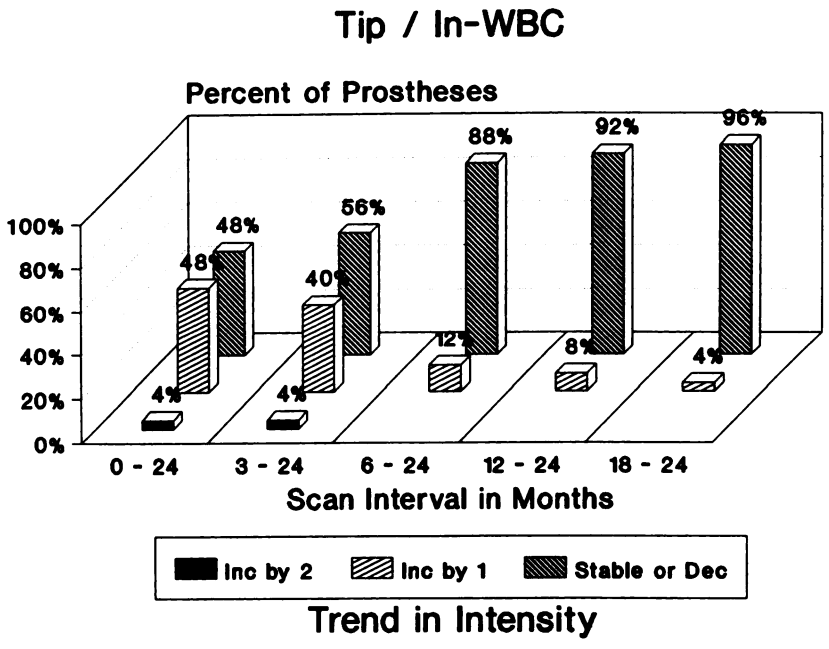

FIGURE 14
The graph shows the percentage of prostheses demonstrating a trend in changing In-WBC intensity for a given time interval. For example, during the interval encompassing 3 to 24 mo, 56% showed stable or decreasing activity with 40% and 4% demonstrating increases by one and two intensity grades, respectively.

individual prosthesis demonstrated a clear trend toward stable or decreasing activity with serial scanning.

When compared to the corresponding bone phase images, the intensity of In-WBC uptake at the tip was less than or equal to the intensity of [Tc]MDP uptake in 85% of prostheses. This is an area where the semiquantitative measurement of [Tc]MDP/In-WBC uptake ratios may be of value.

Since the presence or absence of In-WBC uptake at the tip alone does not necessarily yield a diagnosis of infection and since consideration of changing activity with serial scanning may be helpful, a baseline scan becomes of value. The graph demonstrating intensity trends for the individual prostheses (Fig. 14) may be helpful in determining an optimal time to perform a baseline scan.

In summary, for the TPBS, (a) minimally increased blood flow was seen in only one of 136 flow studies; (b) minimally increased focal blood-pool activity was seen in only two of 136 blood-pool images; (c) diffusely increased blood-pool activity throughout the muscles of the thigh was seen in 11 of 25 prostheses (20 of 136 scans); and (d) [Tc]MDP uptake was universally seen at some time during the first 24 mo. Furthermore, in the medial segment of the prosthetic tip, intensity of [Tc]MDP uptake was stable or decreasing during the 3 to 24 mo study interval (22 of 25 PCHA) and was always less than or equal to the lateral segment beyond the immediate postoperative period.

For the In-WBC studies, (a) uptake was frequently present (80% of PCHA) at some time during the first 24 months; (b) the intensity of In-WBC uptake was always less than or equal to the iliac crest; (c) the pattern of uptake was either focal (55%) or "diffuse linear" (45%); (d) the intensity of In-WBC uptake was stable or decreasing in 88% of PCHA during the 6- to 24-mo study interval; (e) no patient demonstrated an increase in intensity with serial scanning by more than two grades during the first 24 mo; and (f) the intensity of In-WBC uptake was less than or equal to the intensity of [Tc]MDP uptake in 85% of PCHA.

It is important to recognize that the recommendations cited below are unconfirmed. The fact that we did not observe a particular finding in our "normal" patient population does not imply that the presence of that finding should necessarily be considered abnormal. It is possible that because of the sample size and potential for sampling error we did not observe a particular finding when, in fact, that finding may also be found in the uncomplicated patient.

RECOMMENDATIONS

Based on this 2-year prospective study, we make the following recommendations in the interpretation of [Tc]MDP and In-WBC scintigraphy as they pertain to the tip of the porous coated prosthesis.

TPBS.
1. Any increased flow or focal blood-pool activity should strongly raise the suspicion of a complication.
2. Diffuse blood-pool activity involving the entire thigh is not indicative of a complication.
3. The frequency of [Tc]MDP uptake at 1 and 2 years is greater than would be expected with a cemented prosthesis and its presence alone should not necessarily be interpreted as representing a complication.
4. One should consider the possibility of an existing complication when uptake in the medial segment is: (a) greater than the lateral segment from 3 to 24 mo, (b) increasing with time from 3 to 24 mo, or (c) greater than the iliac crest from 12 to 24 mo. Conversely, increasing uptake with time in the distal and lateral segments should not necessarily be interpreted as representing a complication.
5. A baseline TPBS is of value to evaluate changing intensity.
6. The type of prosthesis (porous coated or uncemented) appears to be of importance in scan interpretation.

In-WBC.
1. The presence of In-WBC uptake does not necessarily indicate the presence of infection.
2. Infection of the PCHA should remain in the differential diagnosis if there is: (a) In-WBC uptake greater than the iliac crest, (b) any pattern of activity other than focal or "diffuse linear", (c) any increasing In-WBC uptake on serial scanning after 6 mo, and/or (d) any increase in In-WBC uptake on serial scanning by more than two intensity grades during the first 24 mo.
3. Congruence of intensity or pattern has little clinical utility.
4. A bone scan utilizing the same camera is recommended to better assess the location of the prosthesis tip on In-WBC scintigraphy.
5. A baseline In-WBC scan is of value.

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