Radionuclide Arthrography and Transmission Imaging for Assessment of Painful Hip Prostheses

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Interpretation of the radionuclide hip arthrogram may present difficulty because of a lack of anatomical reference information. Additional transmission images to determine tracer localization may facilitate scan interpretation. **Methods:** Isotope arthrography (20 MBq ^{99m}Tc-tin colloid and ^{57}Co transmission imaging) was prospectively performed on 21 patients with painful hip prostheses and suspected stem loosening. **Results:** The radionuclide arthrogram was positive in 10 patients and negative in 9 patients. Extravasation of tracer, confirmed by transmission images, resulted in two nondiagnostic studies. Surgery was undertaken in 10 patients and loosening was confirmed in 6 patients. In this surgical subgroup, the scan was true-positive in six patients, true-negative in two patients, false-positive in one patient and nondiagnostic in one patient. **Conclusions:** The combination of radionuclide arthrography and transmission imaging facilitates scan interpretation and is a recommended method for investigating suspected loosening of the femoral stem.

Key Words: hip prosthesis loosening; radionuclide arthrogram; transmission imaging

J Nucl Med 1994; 35:851–854

Evaluation of painful hip prostheses for loosening of the femoral component remains a difficult clinical and diagnostic problem. Diagnostic tests include plain film x-ray, radiographic contrast arthrography and radionuclide arthrography. The radionuclide arthrogram is the preferred test for assessment of femoral stem loosening (*1–6*).

Interpretation of the radionuclide arthrogram may be difficult because of poor anatomic reference information. Additional ^{57}Co transmission images for orientation of tracer movement may facilitate scan interpretation (*4,7*).

Low-dose ^{99m}Tc-tin colloid arthrography and ^{57}Co transmission imaging were used to prospectively study 21 patients with painful hip prostheses and suspected stem loosening.

The methodology and results are discussed, and reference is made to the interpretation of the radionuclide arthrogram for cemented and noncemented prostheses.

Received July 23, 1993; revision accepted Jan. 20, 1994.

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PATIENTS AND METHODS

Twenty-one patients were studied (Table 1). There were 15 males and 6 females (mean age, 62 yr; range, 35–85 yr). All patients were referred for assessment of painful hip prostheses where loosening of the femoral stem was suspected, and plain film radiology was either negative or equivocal for loosening.

Under sterile conditions, a needle was placed into the hip joint using a fluoroscopic control for correct needle positioning. Technetium-99m-tin colloid [20 MBq (~0.5 mCi in 0.5 ml)] was injected into the hip joint. The patient was then encouraged to ambulate, and imaging was performed 3 to 6 hr postinjection (GE 400 AT camera linked to a Star 4000 computer).

Two views were taken (anterior and lateral) using a high-resolution collimator. For the ^{99m}Tc-colloid views, images were obtained for a maximum of 10 min or 300K on a 133–161 keV window setting. Without moving the patient, a ^{57}Co transmission image was obtained after each of these views. The ^{57}Co flood [370 MBq (−10 mCi)] was positioned under the table and the transmission image was obtained on a 110-keV to 134-keV window setting for a maximum of 10 min or 2000 K.

The films were then read by a nuclear physician. The criterion for diagnosis of prosthesis loosening was abnormal tracking of radionuclide at the bone/femoral stem interface.

The surgical criterion for loosening of the femoral component was obvious movement upon manipulation of the femoral stem at surgery leading to easy removal.

RESULTS

The radionuclide arthrogram was positive (Fig. 1) for femoral stem loosening in 10 patients and negative (Fig. 2) for stem loosening in 9 patients. Extravasation of tracer (Fig. 3) identified on ^{57}Co transmission images resulted in two nondiagnostic studies.

Surgery was performed on 10 patients (3 cemented, 7 noncemented prostheses). In this surgical subgroup, femoral stem loosening was present in six patients but not in four patients. The arthrogram was true-positive for stem loosening in six patients (two cemented, four noncemented prostheses), true-negative for loosening in two patients (one cemented, one noncemented prosthesis) and false-positive for stem loosening in one patient (noncemented prosthesis). In the noncemented-stem-loosened patient,

TABLE 1
Patient Data

Patient no.	Age/Sex	Prosthesis	Arthrogram	Surgical findings
1	85/F	NC	Pos	Loose
2	57/M	C	Ex	None
3	77/M	C	Pos	Loose
4	22/M	C	Neg	None
5	65/M	NC	Neg	None
6	64/M	NC	Neg	None
7	56/M	NC	Neg	None
8	54/M	C	Pos	Loose
9	74/M	NC	Pos*	Not loose
10	74/F	C	Pos	None
11	35/F	C	Neg	Not loose
12	57/M	NC	Ex	Not loose
13	51/F	NC	Pos	None
14	66/F	NC	Pos	Loose
15	44/M	NC	Pos	None
16	82/M	NC	Pos	Loose
17	65/M	NC	Pos	Loose
18	72/M	NC	Neg	Not loose
19	70/M	C	Neg	None
20	43/F	C	Neg	None
21	79/M	C	Neg	None

*Tracking on one side of stem reported as early loosening.
C = cemented; NC = noncemented; Pos = positive; Neg = negative for loosening; Ex = extravasation.

tracking of tracer was only seen down one side of the cementless femoral stem and reported as suspicious of early loosening (Fig. 4). Surgery was performed in one of the two patients with nondiagnostic studies due to extravasion; the stem was not found to be loose during surgery.

DISCUSSION

More patients are being referred for investigation of postsurgical complications, such as suspected femoral stem loosening, because of the increased number of joint replacements being performed.

Revision surgery, perhaps more difficult to perform than primary surgery, is known to have an increased complication rate. For this reason, it is important to refine current techniques for diagnosing stem loosening and provide correct information before a decision is made to undertake surgical revision.

Plain film radiology and contrast arthrography do not reliably detect stem loosening, and the radionuclide arthrogram is currently the preferred investigation for assessing stem loosening (*1–5*). Interpretation of the radionuclide arthrogram may be difficult because of poor reference information. Anatomic reference information may be obtained by either transmission imaging or dual radionuclide scanning (*1,4,6,7*).

Cobalt-57 transmission imaging to localize intra-articular radionuclide was first described by Uri et al. in 1984 (*4*). This article does not provide details about the methodology for transmission imaging, and some of the examples of transmission images required additional skin markers for orientation. Our technique uses current technology which results in improved image resolution, including visualization of the prosthesis appearing as a photopenic defect. This was not achievable 10 yr ago.

Dual-radionuclide studies using ^{111}In-DTPA arthrography and ^{99m}Tc-MDP have been performed with good results, but they require the administration of a second dose of radionuclide. The use of a dual radionuclide study for reference information results in additional cost. As in many other fields of medicine, nuclear medicine needs to minimize the cost of its diagnostic procedures (*8*). It should be noted that good quality reference information is obtained from a ^{57}Co transmission image. This method does not require the administration of a second dose of radionuclide and provides equivalent information at no additional cost.

In our study, we obtained satisfactory data using low-dose ^{99m}Tc-tin colloid arthrography to enable good quality ^{57}Co transmission views in the anterior and lateral projection. With this method, we were able to correctly diagnose stem loosening in six of seven patients (86% sensitivity). The test was true-negative for loosening in two of two patients (100% specificity). The one false-positive report occurred in a patient who had a cement-free prosthesis in which the arthrogram showed some tracking of tracer down one side of the stem only. The stem was not loose at surgery and the scan finding is probably explained by irregular ingrowth of bone around the stem of the prosthesis (*7*). The other true-positive arthrograms in our series of patients with cement-free prostheses showed more extensive tracking of tracer around the femoral stem.

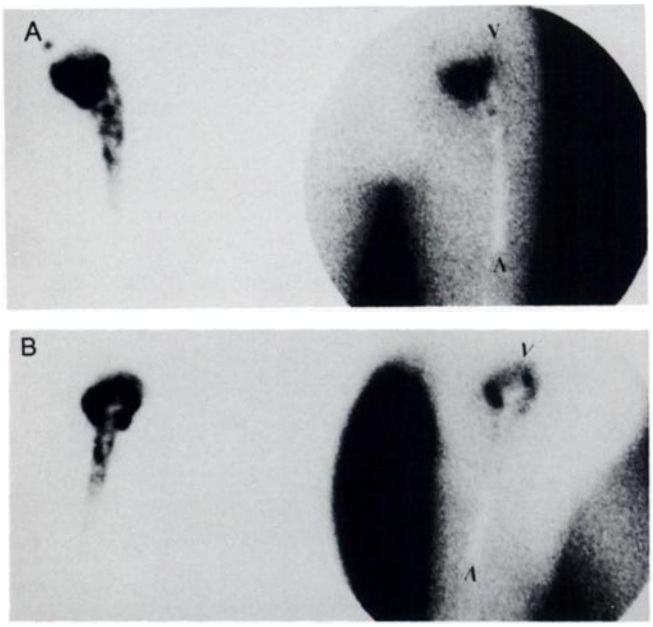

FIGURE 1. Anterior (A) and lateral (B) images of left-hip radionuclide arthrogram (^{99m}Tc-tin colloid) and transmission scans (^{57}Co flood) at 3 hr postinjection show tracking of tracer around the femoral stem. The study is positive for loosening of the stem. The line of the femoral component is indicated by V on the transmission images.

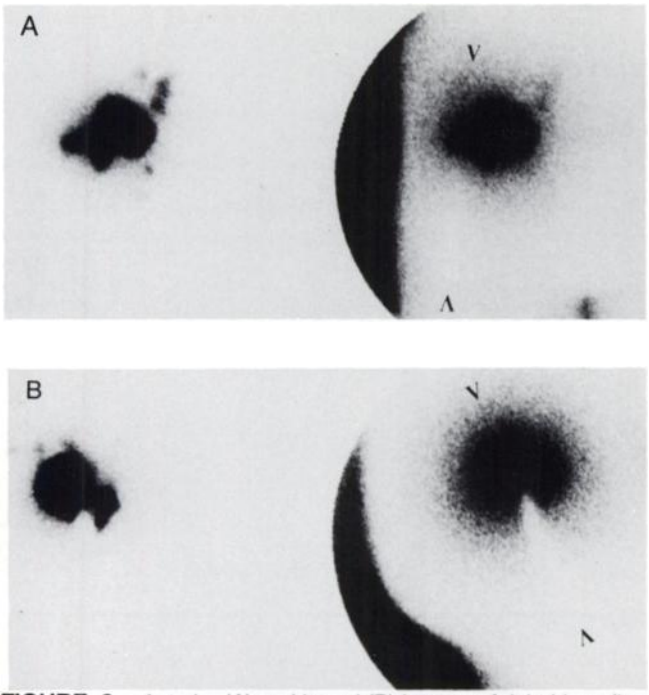

FIGURE 2. Anterior (A) and lateral (B) images of right-hip radionuclide arthrogram (^{99m}Tc-tin colloid) and transmission scans (^{57}Co flood) at 3 hr postinjection show activity confined to the joint space. There is no tracking of tracer at the bone/femoral stem interface. The study is negative for stem loosening. The line of the femoral component is indicated by V on the transmission images.

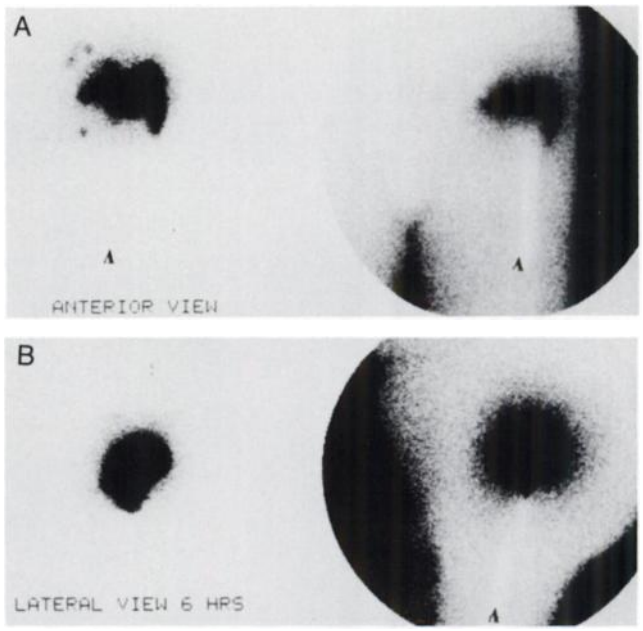

FIGURE 4. Anterior (A) and lateral (B) images of left-hip radionuclide arthrogram (^{99m}Tc-tin colloid) and transmission scans (^{57}Co flood) at 6 hr show the tracking of a small amount of tracer on the lateral aspect of the upper femoral shaft. The study was reported as early loosening but was false-positive. The stem was found to be firmly in position at operation. The line of the femoral component is indicated by V on the transmission scans and on the anterior colloid image.

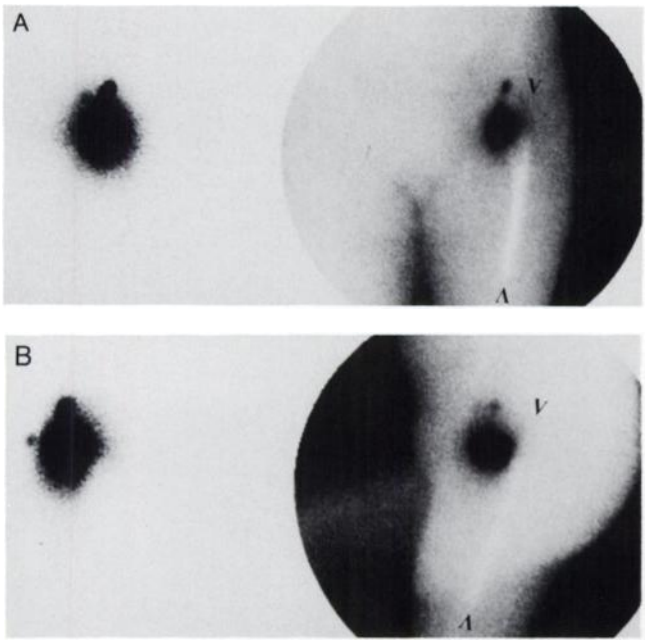

FIGURE 3. Anterior (A) and lateral (B) images of left-hip radionuclide arthrogram (^{99m}Tc-tin colloid) and transmission scans (^{57}Co flood) show soft-tissue extravasation of activity anterior to the femoral neck. The study was reported as nondiagnostic and a repeat study, although recommended, was not performed. The femoral stem was not loose at surgery. The line of the femoral component is indicated by V on the transmission images.

The dose of ^{99m}Tc-tin colloid used for radionuclide arthrography varies from 0.5 to 1 mCi. The interval between injection of radionuclide and scanning ranges from immediate postinjection to a delay of 24 hr (*2–5,7*). The use of a low dose of ^{99m}Tc-tin colloid (20 MBq ~ 0.5 mCi) and a delay of 3–6 hr should allow sufficient time for the tracking of tracer and provide optimal ^{57}Co transmission images.

We now believe that the tracking of a small amount of tracer around a noncemented stem should be interpreted with caution to avoid false-positive results. In these cases, serial studies showing more extensive tracking of tracer around the stem would be necessary to confirm loosening.

The purpose of this study was to investigate a selected group of patients referred for suspected loosening of the femoral component. In our practice, if acetabular loosening is suspected, patients are referred directly for radiographic arthrography, the preferred test for investigating acetabular component loosening. In cases where loosening of both components is suspected, combined radionuclide and radiographic contrast arthrography is recommended (*3,6*).

The combination of radionuclide arthrography and ^{57}Co transmission imaging yields excellent anatomic reference information for arthrogram interpretation and is a recommended method for investigating suspected loosening of the femoral stem of hip prostheses.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Laraine Turner and Michelle Woods for preparation of the manuscript. They also thank Shayne White, Helen Geijsel, Jane Hassell and Alison Campbell for technical assistance.

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Condensed from

15 Years Ago:

Single-Photon Transaxial Emission Computed Tomography of the Heart in Normal Subjects and in Patients with Infarction

B. Leonard Holman, Thomas C. Hill, Joshua Wynne, Richard D. Lovett, Robert E. Zimmerman and Edward M. Smith

Harvard Medical School and Peter Bent Brigham Hospital, and New England Deaconess Hospital, Boston, Massachusetts

Resting computerized transaxial tomography was performed after intravenous injection of ^{201}Tl in six normal subjects and five patients who had had myocardial infarctions 3 mo to 4 yr before scintigraphy. Decreased myocardial activity corresponded to the site of previous infarction in all cases and was clearly separated from adjacent myocardium with normal activity. With tomography, the left ventricle was clearly separated from surrounding structures such as the left ventricular cavity, the lungs, and the liver. This study demonstrates the feasibility for the assessment of myocardial perfusion using single-photon transaxial emission computed tomography.

J Nucl Med 1979; 20:736-740