Indium-111-Labeled Leukocyte Scan in Detection of Synthetic Vascular Graft Infection: The Effect of Antibiotic Treatment

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To determine the sensitivity and specificity of the indium-111- (^{111}In) labeled leukocyte scan for prosthetic vascular graft infection in patients treated with antibiotic therapy, a retrospective study was performed. Of 41 consecutive ^{111}In-labeled leukocyte scans performed to evaluate possible vascular graft infection, 23 scans were performed in patients treated with antibiotics. The average duration of antibiotic therapy was 21 days. Twelve positive and 11 negative scans for graft infection were found. By surgical and autopsy correlation of all positive cases, and clinical correlation (of all negative cases), there were 10 true-positive, 11 true-negative, 2 false-positive, and no false-negative scans for graft infections, for an overall sensitivity of 100% and specificity of 85%.

J Nucl Med 1991; 32:13–15

Infection of a synthetic vascular graft is a serious complication of vascular surgery associated with high morbidity and mortality rates (*1*). Although the utility of indium-111- (^{111}In) labeled leukocyte studies for detecting infections, including synthetic vascular graft infections, has been well documented (*2–6*), the sensitivity of the imaging procedure in patients who have received antibiotic therapy has been questioned (*7,8*). This retrospective study was performed to evaluate the sensitivity of ^{111}In-labeled leukocyte scintigraphy for the diagnosis of synthetic vascular graft infection in patients treated with antibiotics.

MATERIALS AND METHODS

All ^{111}In-labeled leukocyte scans performed between January 1986 and March 1990 in patients with synthetic vascular grafts who also received antibiotic therapy were reviewed. One radiologist read the scans without knowledge of the final diagnosis. A scan was classified as positive for graft infection if any linear focus of activity was seen along the synthetic vascular graft. All other scans were interpreted as negative for graft infection. Graft site culture and surgical or autopsy findings as well as clinical follow-up were used in all cases to determine the presence of graft infection. The type and duration of antibiotic therapy prior to the scan were recorded for each patient. If the infectious agent demonstrated resistance to the antibiotic therapy on microbiologic culture test, that antibiotic was not included in the study.

Leukocyte labeling was performed by the method described in the package insert for ^{111}In-oxyquinoline solution (Amersham Corp., Arlington Heights, IL) using 48 ml of the patient's blood with the addition of 7 ml of ACD formula B (Ferrwall Lab., Deerfield, IL) and 7 ml of 6% Hetastarch (DuPont, Wilmington, DE). Labeling efficiency for all samples was greater than 80%.

Spot images of the thorax, abdomen, pelvis and legs were obtained at 24 hr after injection of 18.5MBq (0.5 mCi) of ^{111}In-labeled leukocytes using a medium-energy parallel-hole collimator on a large field of view camera. All images were obtained with a 15% window setting at 170 keV and 245 keV photopeak for the lesser of 600 sec or 300K counts.

The sensitivity and specificity of the ^{111}In-labeled leukocyte scans were calculated in the usual manner.

RESULTS

Of the 41 ^{111}In-labeled leukocyte scans performed in patients with synthetic vascular grafts, 23 were performed on patients receiving antibiotic therapy. (Eleven scans with the pertinent patient's chart were irretrievable due to recent hurricane damage. Of the 11 missing charts, 5 were performed on patients who had no prior antibiotic therapy. Of the remaining six, two patients died and had no autopsy. Two patients had true-positive scans and two had true-negative scans, but no details of hospitalization could be retrieved.)

The mean age was 60 yr (range 44–81 yr). The mean duration of antibiotic therapy was 18 days (range 3–44 days) for scans performed on patients with a graft infection and 22 days (range 3–74 days) overall. The average duration of clinical follow-up was 19 wk (range 3–100 wk) in the group that showed no evidence of infection. The average time from placement of the synthetic graft and the ^{111}In-leukocyte scanning was 14

Received Jan. 22, 1990; revision accepted July 6, 1990.

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mo (range 1–24 mo) in patients with a graft infection and 22 mo (range 1–156 mo) for all scans. The antibiotics administered were clindamycin, vancomycin, gentamicin, tobramycin, metronidazole, amikacin, nafcillin, ticarcillin, cefotetan, and imipenum. The sites of grafts included 21 aorto-iliac-femoral and 5 peripheral with 3 patients having multiple grafts.

Of the 23 scans performed, 12 were positive and 11 negative. Of the 12 positive scans, 10 had graft infection and 2 had no graft infections, with 10 true-positive scans and 2 false-positive scans. Of the 11 negative scans, none had graft infection (11 true-negatives). The overall sensitivity and specificity for vascular graft infection was 100% and 85%, respectively (Table 1).

DISCUSSION

Synthetic vascular graft infection is a dreaded complication of vascular bypass surgery which may present up to 87 mo post-surgery with a mean interval of 27 wk (*1*). The associated mortality rate of graft infection varies by anatomic site and ranges from 48% in aorto-iliofemoral infections to 10% in femoropopliteal infections (*1*). The major morbidity, amputation of the infected graft limb, occurs in 23%–36% of graft infections (*1*). In our small sample of patients with proven graft infection, one patient died of sepsis and another required amputation. The graft infections presented between 1–24 mo post-surgery with an average of 14 mo.

Multiple imaging modalities have been used to detect vascular graft infection, including ultrasound, arteriography, gallium scanning, and computed tomography. Recently, ^{111}In-labeled leukocyte imaging was used to detect synthetic vascular graft infection with sensitivity and specificity reported to be as high as 100% and 85%, respectively (*2,4,5,9,10*). However, as antibiotic therapy is felt to decrease chemotaxis, a lower sensitivity of ^{111}In-labeled leukocyte scan has been suggested in patients receiving antibiotic therapy (*7,8*). In this retrospective study of patients treated with antibiotics prior to scanning, we found the sensitivity and specificity of ^{111}In-labeled leukocyte scan for detection of synthetic vascular graft infections to be 100% and 85%, respectively.

In one patient, a long area of increased activity was seen at the site of graft anastomosis, which was interpreted to represent graft infection. Subsequent angiography demonstrated a pseudoaneurysm at the distal anastomosis, and clinical follow-up of 2 yr failed to demonstrate a graft infection. Pseudoaneurysm has been reported to demonstrate increased uptake of ^{111}In-

TABLE 1
Summary of ^{111}In-Labeled Leukocyte Scans Performed on Patients with Vascular Graft Who Were Receiving Antibiotic Therapy

Scan no.	Age	Scan finding	Final diagnosis	Age of the graft (mo)	No. of days on antibiotic	Clinical follow-up (wk)
1	58	+	+	9	5	
2	57	+	+	7	35	
3	81	+	+	156/20	4	
4	57	+	+	5	7	
5	72	+	+	12	3	
6	57	+	+	24	5	
7	72	+	+	13	14	
8	60	+	+	1	21	
9	44	+	+	24	42	
10	44	+	+	24	44	
Average: 60				14	18	
11	66	+	–	36	4	100
12	65	+	–	36	20	20
13	69	–	–	1	27	16
14	67	–	–	136/60	3	12
15	55	–	–	2	3	12
16	52	–	–	1/1	15	70
17	55	–	–	1	60	75
18	57	–	–	1	25	38
19	57	–	–	1	11	40
20	56	–	–	1	17	4
21	58	–	–	2	57	4
22	71	–	–	3	74	24
23	61	–	–	13	7	12
Total average: 60				23 mo	22 days	19 wk

FIGURE 1
Twenty-four-hour anterior image of the pelvis demonstrating activity along the right femoropopliteal graft.

labeled leukocytes (*11*), and it most likely accounts for the false-positive scan in this patient. In the second patient with a false-positive scan, angiography demonstrated a thrombosed graft which was placed 3 yr prior to scanning with no evidence of a pseudoaneurysm. A 20-wk clinical follow-up failed to demonstrate a graft infection and no definite cause for the positive scan was found.

Pertinent details of the hospitalization of six patients treated with antibiotics and studied with ^{111}In-labeled leukocyte scans were irretrievable. Thus, they were excluded from the study. If these patients' data were included (1 positive and 1 negative scan without clinical correlation, 2 true-positive and 2 true-negative scans proven by surgery and clinical correlation, but lacking data concerning specific antibiotics or time of treatment), there would be 12 true-positive, 13 true-negative, 2 false-positive, 0 false-negative, and 2 undetermined data. Under the worst case scenario (two scans without clinical correlation assumed to be a false-positive and a false-negative scan), the resultant sensitivity and specificity would be 92% and 81%, respectively. Comparison of this sensitivity and specificity with those of 100% and 85% after exclusion of the six patients show that the differences in sensitivity and specificity are not significant ($p > 0.05$).

Thus, in this small series of patients with synthetic vascular grafts who have received prior antibiotic therapy, neither the sensitivity nor the specificity of ^{111}In-labeled leukocyte scan was adversely affected for detection of graft infection. As such, ^{111}In-labeled leukocyte scans remain a sensitive test for detection of synthetic vascular graft infection.

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ADDENDUM

In the October 1990 Laboratory Studies article, "Investigation of Physicochemical and In-Vivo Behavior of Diastereomeric Iron-59, Gallium-68, and Indium-111-EHPG Trivalent Metal Complexes," by Susan L. Madsen, Christopher J. Bannochie, Arthur E. Martell, Carla J. Mathias, and Michael J. Welch, The identification curves in Figure 2 (p. 1666) are as follows: ● liver, ▲ small intestine, and ♦ upper large intestine.