Detection of Prosthetic Vascular Graft Infection Using Avidin/Indium-111-Biotin Scintigraphy

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Prosthetic vascular graft infection, though rare, carries high morbidity and mortality rates; therefore, timely diagnosis is important. Patients, however, often present with vague symptoms, and radiological investigations are frequently inconclusive. These factors may lead to prolonged periods of observation and hospitalization, with the resultant increase in costs and complication rates, before reaching a final diagnosis. This prospective study evaluates the use of nonspecific avidin/^{111}In-biotin imaging in diagnosing prosthetic vascular graft infection. **Methods:** Twenty-five patients with a total of 29 grafts were investigated. Eighteen patients (19 grafts) had low probability of disease, whereas the remaining 7 patients (10 grafts) warranted surgical exploration based on clinical, laboratory or radiological evidence. Avidin was first injected intravenously and then followed 24 hr later by administration of ^{111}In-biotin. Whole-body images were obtained 10 min and 2 hr postinjection of ^{111}In-labeled biotin. SPECT imaging was performed 1 hr postinjection. Increased uptake along part or the whole length of the graft was considered evidence of graft infection. **Results:** Avidin/^{111}In-biotin scintigraphy correctly identified all infected grafts, as confirmed by culturing surgical specimens. In contrast, infection was correctly excluded in all but one of the grafts, and long-term follow-up was used to assess the presence of infection in patients who did not undergo surgical intervention. **Conclusion:** Avidin/^{111}In-biotin scintigraphy is a simple and accurate imaging method for the routine diagnosis of vascular graft infection, and it may have a role in identifying the disease process in its initial stages, thus improving prognosis.

Key Words: prosthetic vascular graft infection; avidin/indium-111-biotin

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Prosthetic vascular graft infection is a rare but serious complication of vascular reconstruction surgery, with a reported incidence of 1.3%–6% (*1*). Once established, infection is associated with high mortality rates ranging from 25% to 75% (*2–10*). Presentation is often unclear and there may be a long time-interval between graft implantation and presentation with infection. One series reported an average interval of 39 mo (*11*). Thus, timely diagnosis and intervention depends on careful follow-up combined with accurate diagnostic procedures.

Several imaging techniques have been proposed to establish whether infection is present or not. Ultrasound has been shown to be nonspecific (*12*), while the diagnosis of graft infection using CT appears to depend on the diagnostic criteria used (*13*). MRI may also be helpful in evaluating vascular prostheses (*14*), but, along with the other radiological methods, it shares the problem of low specificity. Moreover, large-scale studies demonstrating the usefulness of MRI in diagnosing infected vascular prostheses are lacking.

Radionuclide techniques used to assess graft infection have included ^{67}Ga, ^{111}In-labeled white blood cells (^{111}In-WBC) and, more recently, ^{99m}Tc-HMPAO-labeled WBC and nonspecific ^{111}In-labeled immunoglobulin G (^{111}In-IgG). The ^{67}Ga scan has been largely superceded, as it is difficult to interpret, especially in the abdomen where there is high background accumulation in the spleen, liver and gastrointestinal tract. The ^{111}In-WBC scan has gained widespread clinical acceptance as a sensitive and reasonably specific investigation in the diagnosis of vascular prosthetic infection (*15–18*). Some authors maintain, however, that CT is superior to ^{111}In-WBC scintigraphy in the detection of infected vascular prostheses (*19*).

Technetium-99m-HMPAO-WBC scanning compares well with ^{111}In-WBC scintigraphy (*11*) and has certain advantages in that ^{99m}Tc is readily available and has ideal imaging properties. Both methods, however, have the disadvantage of a relatively laborious preparation technique. Nonspecific ^{111}In-IgG scintigraphy has been used recently in several studies and has been shown to give similar results to ^{111}In-WBC scintigraphy in detecting infection/inflammation (*20–23*). Furthermore, IgG is available as a kit and is relatively easy to prepare when compared to radiolabeled WBCs. The problem with nonspecific IgG, and any other radiolabeled protein, is the relatively slow clearance from the circulation resulting in suboptimal target-to-nontarget ratios.

A new and relatively simple approach to routine infection imaging is currently being evaluated. This technique uses avidin and ^{111}In-biotin. Unlabeled avidin, a protein which accumulates nonspecifically at sites of inflammation or infection, probably by capillary leakage, is injected intravenously. Twenty-four hr later, ^{111}In-biotin is injected: part of this binds to the avidin molecules present in the focus of infection, the remainder shows rapid clearance from the circulation and renal elimination. Avidin is therefore used as a pretarget. Due to its rapid clearance from the circulation and the low dissociation constant (10^{-15} *M*) with biotin, one can expect satisfactory target-to-nontarget ratios using this technique (*24*). Preliminary studies (*24,25*) have yielded encouraging results. When compared to nonspecific labeled IgG, the avidin/biotin system showed improved localization ratios at earlier imaging times.

The aim of this work was to evaluate the feasibility of avidin/^{111}In-biotin scintigraphy in identifying infected vascular graft prostheses, in various types of grafts.

MATERIALS AND METHODS

Patients

We studied a total of 29 vascular grafts in 25 patients (22 men, 3 women) with a mean age of 67 yr (range 55–78 yr), after written informed consent was obtained in compliance with the guidelines provided by the Institute H. San Raffaele Ethical Committee. Five of these patients had more than one graft. The sites of graft placement were as follows: 3 aortic, 2 aortoiliac, 16 aortobifemoral and 8 femoropopliteal. Graft material was Dacron in 15 patients

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TABLE 1
Patients Selected for Surgical Exploration (Group A)

Patient no.	Age (yr)	Sex	Graft site/Material	Presentation	Scintigraphy	Treatment and outcome
1	55	M	Ao-Bf/Dacron	Fever, flank pain	Positive	Graft excision and axillo-bifemoral reconstruction
2	67	M	L FP/PTFE R FP/Dacron	Fever	Negative Positive	Graft excision and forefoot amputation
3	59	F	L FP/Dacron R FP/Dacron	Draining	Negative popliteal wound Positive	Surgical drainage and antibiotics
4	75	M	Ao-Bf/Dacron	Draining inguinal wound	Positive	Surgical drainage and antibiotics
5	76	M	L FP/Dacron	Periprosthetic fluid on US	Positive	Surgical drainage and antibiotics
6	62	M	Ao-Bf/Dacron R FP/Dacron	Fever	Negative Positive	Surgical drainage and antibiotics
7	63	M	Ao-Bf/Dacron	Fever	Positive	Graft excision and cadaveric graft

and polytetrafluorethylene (PTFE) in 14. The patients were divided into two groups.

Group A (Table 1) consisted of 7 patients (10 grafts) in whom surgical exploration of the graft was performed. These patients had a high probability of graft infection based on clinical, laboratory or radiological evidence such as discharging surgical wound, persistently elevated erythrocyte sedimentation rate (ESR) or C reactive protein (CRP), repeat positive blood cultures or suspicion of graft infection on US, CT or MRI. The decision to perform surgical exploration on these patients was made by the vascular surgeons prior to the isotope scan.

Group B (Table 2) consisted of 18 patients (19 grafts) with a low probability of graft infection, in that they either had regular follow-up or minimal signs of a focus of infection (such as pyrexia, transiently elevated ESR or CRP, or positive blood culture) that resolved spontaneously or following a short antibiotic course. These patients did not undergo surgical exploration. They served as a control group to assess the specificity of the method.

The interval between graft placement and scintigraphy varied from 2 wk to 36 mo, with a mean of 5.25 mo. Management of the patients followed the normal practice in our hospital and was not influenced by scintigraphic results. All patients were evaluated in

TABLE 2
Patients with a Low Probability of Disease (Group B)

Patient no.	Age	Sex	Graft site/Material	Presentation	Scintigraphy	Treatment and outcome
8	65	M	Ao-Bf/PTFE	Fever	Negative (uptake in soft tissues of thigh)	Drainage of abscesses in thigh muscles and antibiotics
9	74	M	Ao-Bf/Dacron	Periprosthetic fluid on US	Negative	No treatment
10	76	M	Ao-Ao/Dacron	Intraop. duodenal perforation	Negative	Short course of antibiotics
11	65	M	L FP/PTFE R FP/Dacron	Fever, draining Inguinal wound	Positive Negative	Wound drainage and irrigation. Occluded 1 yr later—no microbiological evidence of infection
12	78	M	Ao-Bf/Dacron	Intraop. ureteric lesion	Negative	No treatment
13	70	M	Ao-Bf/Dacron	Intraop. duodenal lesion	Negative	No treatment
14	60	M	Ao-Bf/PTFE	R. inguinal hematoma	Negative	No treatment
15	72	M	Ao-Bf/Dacron	Fever, raised ESR, CRP	Negative	Settled on antibiotic treatment
16	74	M	Ao-Bf/PTFE	Fever, positive blood culture	Negative	Settled on antibiotic treatment
17	60	M	Ao-Bf/PTFE	Regular FU	Negative	No treatment
18	72	F	Ao-Ao/PTFE	Regular FU	Negative	No treatment
19	63	M	Ao-I/PTFE	Regular FU	Negative	No treatment
20	60	M	Ao-Bf/PTFE	Regular FU	Negative	No treatment
21	71	M	Ao-Bf/PTFE	Regular FU	Negative	No treatment
22	57	M	Ao-Bf/PTFE	Regular FU	Negative	No treatment
23	69	M	Ao-Ao/PTFE	Regular FU	Negative	No treatment
24	71	M	Ao-I/PTFE	Regular FU	Negative	No treatment
25	60	F	Ao-Bf/PTFE	Regular FU	Negative	No treatment

a standard fashion, utilizing US, CT, MRI and arteriography when indicated. The decision to perform surgery was made by the vascular surgeons on the basis of available clinical, laboratory and radiological data. None of these patients underwent other radionuclide studies.

Reagents

Pure hen egg avidin was obtained from Società Prodotti Antibiotici (S.P.A., Milan, Italy). Diethylenetriaminepenta-acetic acid (DTPA)-conjugated biotin was obtained from Sigma (St. Louis, MO).

Radiolabeling with Indium-111

DTPA-conjugated biotin was diluted in PBS, pH 7.4, to a concentration of 2 mg/ml. The solution was sterilized by 0.22 μm Millipore filtration. Indium-111-chloride was diluted in citrate buffer (0.02 *M*; pH 6.5) to 740 KBq/μl. Reagents were mixed and allowed to react for 10 min at room temperature. Paper chromatography (Whatman 1 paper/bicarbonate buffer 0.05 *M*) confirmed that more than 98% of the ^{111}In was bound to the conjugate. After labeling of the biotin, the ability to bind to avidin was verified by fast-protein liquid chromatography (column Superose 12, eluant saline, Pharmacia, Sweden) by mixing ^{111}In-biotin with an appropriate amount of avidin. No loss of reactivity between the two was observed.

Administration Protocol

Ten milligrams of avidin were added to 100 ml physiological saline and administered intravenously over 30 min. Twenty-four hr later, 500 μg biotin labeled with 74 MBq (2 mCi) ^{111}In were administered intravenously as a bolus injection.

Imaging Protocol

A whole-body scan was acquired 10 min after injection of the labeled biotin using a double-headed gamma camera. Medium-energy collimators with 20% energy windows centered around the 173 and 247 keV energy peaks of ^{111}In were used. Scans were acquired at a speed of 10 cm/min in all patients. Since the urinary tract is the route of elimination of labeled biotin, patients were asked to urinate prior to scanning, as bladder activity significantly interferes with evaluation of the inguinal region. At 1 hr postinjection, SPECT was performed (64 × 64 matrix, 64 projections for 30 sec, over 360°) using a gamma camera equipped with a medium-energy collimator. Reconstructed images were generated using a filtered backprojection algorithm with a Hann filter (cutoff 0.5 pixel^{-1}). The delayed whole-body scan was acquired at 2 hr postinjection.

Toxicity and Immunogenicity

All patients were closely monitored following the administration of avidin. Venous blood samples (5 ml) were obtained in each patient before the administration of avidin and 4 wk later to monitor the immunological response. Avidin immunogenicity (human anti-avidin response, HAAR) was studied on microwell plates coated with avidin separately. The plates were saturated for 1 hr with PBS bovine serum albumin and human serum dilutions were added and incubated for 1 hr at 37°C. After five washes, the binding of human antiavidin antibodies was revealed with horseradish peroxidase-conjugated rabbit anti-human IgG antibodies diluted to 1/1000 for 45 min at 37°C. After six washes, the enzymatic reaction was developed with a chromogenic substrate (*o*-phenylenediamine; Sorin Biomedica) for 10 min and blocked by the addition of 1 *M* H_2SO_4. The optical density reading was 492 nm (*26*).

Blood samples from a population of 83 normal control subjects, who had never received any avidin, were taken to calculate a mean value for antiavidin antibodies and this value was used to obtain a cutoff value between a positive and a negative response. The mean value in this population was found to be 6 U/ml, with a s.d. of 5.5. The cutoff was taken as mean + 3 s.d. (22.5 U/ml). HAAR was considered positive when above this level.

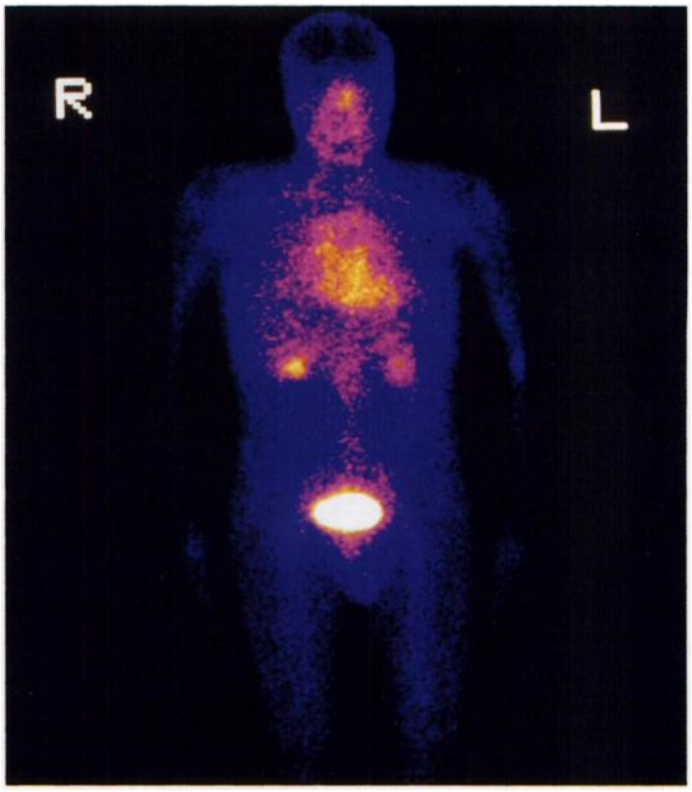

FIGURE 1. Anterior whole-body projection of Patient 20 obtained 10 min following injection of ^{111}In-biotin. The scan revealed no pathological uptake of tracer along the length of the prosthesis and long-term follow-up confirmed the absence of infection.

Surgery and Follow-up

Presence of infection in Group A was established by the finding of pus or necrotic tissue around the graft on surgical exploration or by positive culture of surgical specimens.

Patients in Group B, who were judged to have a low probability of disease by the referring vascular surgeons, were monitored closely for a period of 9–24 mo (mean 17 mo) after scintigraphy; this period of follow-up was considered to be the final arbiter of infection in this group of patients.

Data Analysis

Both planar and tomographic images were interpreted independently by two readers without any prior knowledge of the patient's clinical situation. The scan was considered positive when tracer uptake was seen along the whole length or part of the graft, either on planar or on tomographic images or both. On the other hand, it was considered negative when no tracer uptake was seen relating to the vascular graft, even if a site other than that of the vascular prosthesis was identified on the images obtained as the source of infection or inflammation. In case of disagreement, the images were reviewed by a third reader.

RESULTS

No acute or long-term toxicity following the administration of avidin was observed in this patient population. None of the patients in this group developed a human antiavidin response.

There was 100% agreement between the first two observers for the presence of significant tracer uptake relating to the vascular prostheses. On the other hand, for insignificant tracer

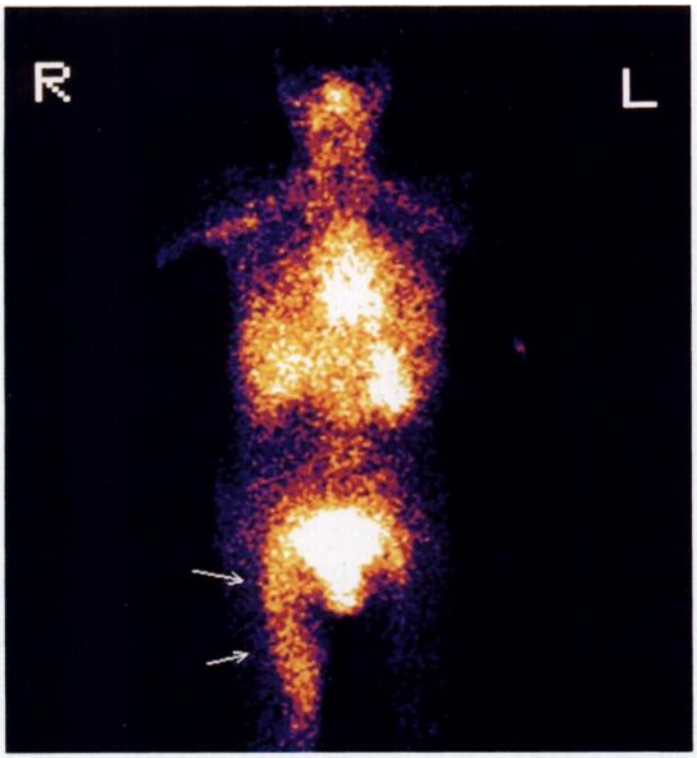

FIGURE 2. Anterior whole-body scan of Patient 6 obtained 10 min following injection of ^{111}In-biotin reveals infection of the right femoropopliteal graft (arrows) without involvement of the aortobifemoral graft.

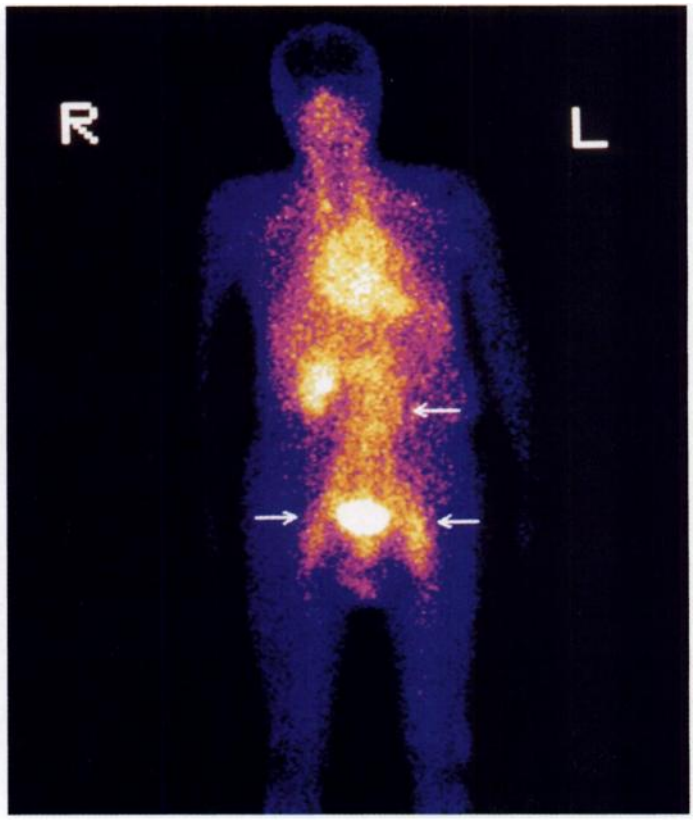

FIGURE 3. Ten-minute whole-body anterior projection of Patient 7. Intense uptake is seen along the whole length of the infected aortobifemoral prosthesis (arrows), particularly along the left femoral limb.

uptake relating to the vascular prosthesis (Fig. 1), there was agreement in all but one of the grafts, resulting in 4.5% disagreement. Furthermore, no difference in scan interpretation was noted between planar and tomographic imaging.

All patients in Group A had a positive scan suggestive of graft infection. In this group, 10 grafts in 7 patients were considered for evaluation.

Of these seven patients, four had a femoropopliteal graft infection which was treated by debridement of perigraft tissue, antibiotic irrigation and healing by granulation. Figure 2 depicts the scan of Patient 6, a 62-yr-old man who had undergone both aortobifemoral graft placement as well as right femoropopliteal graft placement. He presented with fever 4 mo after placement of the latter graft and the isotope scan revealed intense uptake along the length of this graft without involvement of the aortobifemoral graft. A fifth case of femoropopliteal graft infection was treated by excision of the graft and forefoot amputation. The final two patients had aortobifemoral grafts: one was treated by graft excision and axillo-femoral reconstruction, whereas the other was treated by graft excision and cadaveric graft implantation (Fig. 3). In all these patients, infection was proven by culture of perigraft samples or the graft material itself.

In Group B, 19 grafts in 18 patients were evaluated.

In Patient 11, scintigraphy revealed uptake along the whole length of the left femoropopliteal graft, but this was not confirmed by other methods. Infection appeared to be limited to the inguinal wound and culture revealed *P. aeruginosa* infection. Twelve mo later, the graft occluded and required thrombectomy. Culture at the time of this last surgery was negative. The remaining patients have been monitored for an average period of 17 mo (range 9–24 mo) and have not developed any signs of prosthetic infection.

One case worthy of mention in this group is Patient 8, who presented with fever and a swollen left thigh 7 mo following the placement of an aortobifemoral graft. The scan was negative for prosthetic infection but showed intense uptake in the left thigh (Fig. 4). CT confirmed multiple abscesses in the soft tissues of the thigh and this patient fared well following drainage of the abscesses and antibiotic therapy.

Tables 1 and 2 summarize the clinical details and scan findings of the patients in Groups A and B, respectively.

DISCUSSION

An important problem in the field of vascular surgery is the diagnosis of infections in the vascular tree, particularly in the presence of prosthetic grafts. The patient frequently presents with vague and nonspecific symptoms and the clinician requires a diagnostic tool that can determine whether or not these symptoms are a manifestation of graft infection. Clinical judgment certainly is not aided by the fact that the grafts frequently lie in anatomically remote areas such as the retroperitoneum. Given the infrequency of this complication and the distorted anatomy following graft implantation, an accurate and specific test for the diagnosis of vascular graft infections is needed.

With the advent of new imaging modalities, there has been some improvement in the diagnosis of graft infection. Morbidity, however, remains high and the late diagnosis of the problem leads to serious complications, with further debilitation of the patient. One study (*27*) reported a perioperative mortality rate of 25%, a 5-yr limb loss rate of 33% and a 3-yr graft thrombosis rate of 35% in aortic grafts despite aggressive management and timely intervention as soon as diagnosis of the infection was made.

It is thus clear that efforts should be directed towards early

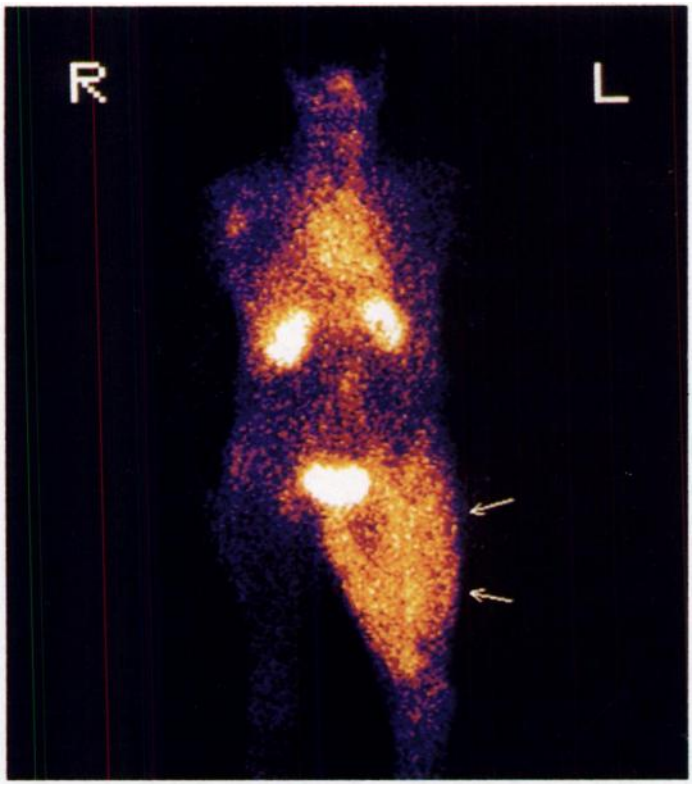

FIGURE 4. Whole-body scan of Patient 8 obtained 10 min postinjection revealed widespread uptake of the tracer in the left thigh (arrows), without involvement of the aortobifemoral prosthesis. CT confirmed multiple abscesses in the muscles of the thigh and the patient fared well after drainage of abscesses and antibiotic therapy.

recognition of vascular graft infection, which will result in a shorter period of observation before a secondary procedure. The benefits of such a strategy are twofold:

1. Earlier intervention results in reduced morbidity and complication rates.
2. The reduced period of observation diminishes hospitalization expenses, an important issue in this era of cost-effectiveness.

Infection Imaging

Several studies have reported good results in detecting prosthetic infection using ^{111}In-WBC imaging (*15–18*). Even though the sensitivity of the ^{111}In-WBC scan has been shown to be 100% in some series (*15,16*), this technique has limitations. The major drawback of the method is the extremely laborious preparation of labeled WBCs, which requires separation, labeling and reinjection of autologous WBCs. A further drawback of ^{111}In-WBC scanning is the use of ^{111}In as the radiolabel. This has far from optimal imaging characteristics and the high radiation dose to the spleen limits the injectable dose to 18.5 MBq (0.5 mCi). False-positive studies have also been reported using ^{111}In-WBC scanning and these have been attributed to the presence of lymphoceles (*28*), sterile pseudoaneurysms (*29*) and hematomas (*30*). Recently, ^{99m}Tc-HMPAO-WBC have also been used with good results in the evaluation of infected vascular prostheses (*11,31,32*).

In the search for simpler methods for infection imaging, researchers have come up with an array of kit preparations. The method receiving the most attention is ^{111}In-labeled polyclonal IgG, and initial trials have demonstrated the sensitivity of the technique in detecting infection (*20–23*). This method has also been shown to be useful in the detection of vascular graft infection (*33*). It was also hypothesized that other radiolabeled proteins could be used (*34*). A major shortcoming of using radiolabeled proteins for infection imaging is the relatively slow clearance of the label from the circulation, which results in low target-to-nontarget ratios, even on delayed imaging. Furthermore, normal uptake of proteins by the liver could interfere with the interpretation of abdominal images.

Pretargeting Methods

These problems have led to the development of the concept of pretargeting, whereby an unlabeled compound that localizes on the lesion is first administered and the excess allowed to clear from the circulation. Subsequently, a radiolabel with a high affinity for this compound and a rapid clearance is administered, and imaging is performed.

Avidin/Biotin System

One of the pretargeting methods currently being investigated makes use of the avidin-biotin system, a system which has already been widely applied in vitro in immunohistochemistry, ELISA and in molecular biology (*35*). Avidin and biotin show a high affinity for each other (Ka 10^{15}) and form a strong noncovalent complex. Thus, small amounts of avidin (10 mg were used in this study) will bind radiolabeled biotin in vivo and the rapid biodistribution and clearance of the latter will result in satisfactory target-to-nontarget ratios in less than 3 hr following injection. The technique has already been applied to tumor imaging with excellent results (*26,36,37*).

Rusckowski et al. (*24*) reported favorable data utilizing unlabeled streptavidin as the pretarget and ^{111}In-labeled biotin as the radiolabel in imaging infection in a mouse model. They compared lesion-to-normal tissue uptake using three different techniques: nonspecific polyclonal IgG, labeled streptavidin and unlabeled streptavidin followed by labeled biotin. The results obtained with labeled streptavidin were similar to those obtained using labeled nonspecific IgG, adding strength to the hypothesis that accumulation of IgG in foci of infection is due to nonspecific capillary leakage. Streptavidin-biotin imaging, on the other hand, resulted in higher target-to-background and target-to-liver ratios, this being the result not of greater lesion uptake but of markedly diminished background activity. Initial studies in humans have confirmed the results of the laboratory studies (*24,25*).

The scope of the present study was to study the behavior of the avidin-biotin system in prosthetic graft material (be it Dacron or PTFE) in the absence of infection and to evaluate the utility of the technique in diagnosing infection of vascular prostheses. Avidin and not streptavidin was used due to the faster clearance of the former. To assess the specificity of the method, we included patients who had a low likelihood of infection on clinical grounds. Scintigraphy was negative in all but one of these patients. SPECT was performed routinely and although it did not improve sensitivity (all positive scans were interpreted as such also on planar imaging), a clearer structural definition was obtained on the transaxial images in some cases.

The dosage of avidin and biotin and the timing between injections and between injection and imaging was chosen on the basis of work previously performed at this institute (unpublished data).

The method correctly identified all 7 infected prostheses in this series and correctly ruled out infection in 21 of 22 grafts. Furthermore, other sites of infection were identified. The method may thus aid the surgeon in choosing the best therapeutic option for the patient, especially in cases where clinical judgment and all other diagnostic results are inconclusive. In the case of scan positivity, the surgeon may operate in the early

stages of the illness, thus markedly improving the prognosis and at the same time reducing the overall costs, particularly with regard to hospitalization.

Other scintigraphic techniques used for inflammation imaging sometimes show activity around the graft in the early postoperative period in the absence of infection. This may be due to a number of factors, such as foreign body reaction or postoperative inflammation (*16,17,38,39*). This should be a problem shared by all scintigraphic techniques used to image vascular prostheses and there is no reason to believe that the avidin-^{111}In-biotin system should behave differently. The earliest scan we obtained, however, was 2 wk following the operation and it was negative.

In patients with pyrexia of unknown origin following prosthetic vascular graft surgery, whole-body scanning is necessary to identify sites of infection that are not related to the graft. Various studies have reported extragraft accumulation of tracer (*15,40*) and, in our series, there was one patient with a soft-tissue infection without graft involvement (Fig. 4). A major advantage of this technique over both labeled WBC and ^{111}In-IgG scintigraphy is the low liver uptake, which results in reduced abdominal activity and easier evaluation of aortic prostheses. On the other hand, the use of the technique in the evaluation of thoracic aortic prostheses can be limited by cardiac blood-pool activity, especially in the early (10-min) images. The high renal activity seen in all the studies does not significantly interfere with image interpretation in the case of abdominal aortic prostheses, as these are almost always midline structures and easily distinguishable from the kidneys. If any doubt should arise, SPECT could easily clarify the precise site of any focal accumulation noted on planar imaging. Other advantages of this new technique include the relative ease of labeling, lack of exposure to and handling of blood products and lack of inadvertent platelet labeling which could result in a false-positive result in the case of a thrombosed graft. Further studies in a larger group of patients are now warranted to compare the results obtained using this technique to those obtained using labeled WBCs and labeled nonspecific human polyclonal immunoglobulins.

Future Perspectives

Current developments may further improve the technique. These include the use of a recombinant avidin to reduce immunogenicity and the use of a currently available biotin molecule that can be labeled with ^{99m}Tc. Furthermore, radiolabeled biotin may be injected just 4 hr after avidin administration without any particular degradation of image quality when compared to administration at 24 hr, which allows the whole procedure to be performed in a single day.

Shoup et al. (*41*) compared the uptake of two different types of ^{18}F-labeled-biotin in *Escherichia coli* infected rats with and without avidin pretreatment. One of these biotin molecules showed an infection-to-normal muscle ratio of 6.08 ± 1.12. This ratio only improved slightly to 6.39 ± 0.96 when avidin pretreatment was used; this suggests that infection localization may be achieved using radioactive biotin alone.

CONCLUSION

Scintigraphy using avidin and ^{111}In-labeled biotin has proven to be accurate in diagnosing infections of vascular grafts. It is simple to perform when compared to labeled WBC imaging and requires no particular laboratory set-up. Recent developments, especially the availability of a ^{99m}Tc-labeled biotin molecule, may further simplify the technique.

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(continued from page 9A)

FIRST IMPRESSIONS:
Technetium-99m-HMPAO Brain SPECT in Progressive Subcortical Gliosis

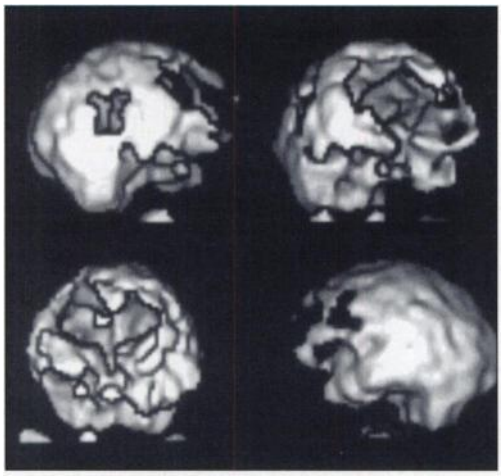

Figure 1.

PURPOSE
A 58-yr-old white woman with a first-time diagnosis of depression, refractory to psychopharmaceuticals and electroshock therapy, was referred to neuropsychiatry department. EEG results were normal. Brain CT and MRI documented cerebral atrophy with bifrontal prominence. Alzheimerís and Pickís diseases were suggested. MR images suggested right frontal lobe gliosis. Neurobehavioral examination was positive for a bifrontal, right fronto-temporo-parietal subcortical dementing process, which was correlated by brain SPECT. Reconstructed three-dimensional images (Fig. 1), with their empty eggshell appearance show extensive bifrontal and right temporo-parietal hypoperfusion. Brain biopsy lead to the unexpected finding of Neumannís disease, a rare condition of progressive subcortical gliosis. The value and need for nuclear neuropsychiatric evaluation of middle-aged patients with new onset behavioral symptomatology is underscored.

TRACER
Technetium-99m-HMPAO, 925 MBq

ROUTE OF ADMINISTRATION
Intravenous

TIME AFTER INJECTION
Sixty minutes

INSTRUMENTATION
General Electric Starcam 3000, single-head XCT detector with a LEHR collimation

ACQUISTION AND RECONSTRUCTION
128 × 128 matrix; 1.33 zoom; 128 frames at 20 sec/frame; 3600 elliptical rotation. Butterworth filter; power factor 10; critical frequency 0.53/cm. Three-dimensional images constructed with distance and gradient shading, 50% threshold.

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