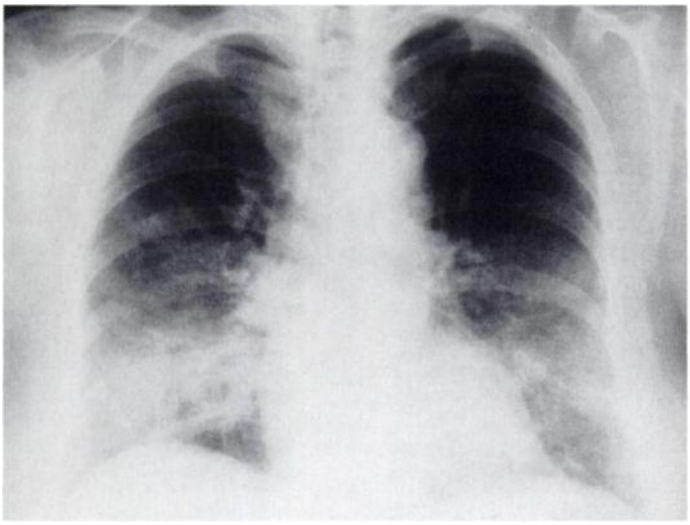

FIGURE 3. Chest radiograph. Posteroanterior view showing bilateral basal infiltrates.

excluded on the presence of p-ANCA, which had not been reported in sarcoidosis (*9,10*), chest radiograph and rapid clinical detoriation of the patient. For ^{99m}Tc-MDP, instant thin-layer chromatography of the administered preparation revealed 0.2% free [^{99m}Tc]pertechnetate. On the bone scans of six other patients who received the same preparation, no lung uptake was seen. The administered ^{99m}Tc-MDP was therefore unlikely to cause lung uptake.

The primarily basal lung uptake on the bone scan corresponded well to the chest radiograph abnormalities discovered 6 days later. These lesions were probably present microscopically when the bone scan was performed and are due to the presence of necrotic or degenerative tissue that sets free intracellular calcium and phosphorus complexes (*1*). The pattern of diffuse and main basal lung uptake might point toward Wegener's vasculitis, as it has not been reported previously.

CONCLUSION

The differential diagnosis of lung uptake on ^{99m}Tc-MDP bone scan should include, among the known causes, Wegener's vasculitis. Additionally, awareness of this diagnosis should prompt nuclear medicine physicians to warn clinicians for a possible rapid clinical detoriation.

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Indium-111-Leukocyte and Technetium-99m-Sulfur Colloid Uptake in Paget's Disease

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We report a case of polyostotic Paget's disease of bone that caused an unusual pattern of accumulation of ^{111}In leukocytes that mimicked, at some sites, uptake of osteomyelitis, which was suspected in this patient. Technetium-99m sulfur colloid scan clarified the nature of ^{111}In-leukocyte accumulation as secondary to expanded active bone marrow uptake in some pagetic bones. Additionally, a spectrum of ^{111}In-leukocyte and ^{99m}Tc-sulfur colloid uptake was noted in the bones involved by the disease that represented uptake by pagetic foci at different pathologic phases of the disease.

This case suggests that Paget's disease should be considered as a diagnostic possibility for areas of ^{111}In-leukocyte accumulation, particularly when expanded uptake is seen. When suspected, correlation with bone marrow scan and/or standard radiographs should be obtained. Recognizing that Paget's disease cannot only cause absent but also expanded bone marrow (depending on the disease stage) and consequently abnormal ^{111}In leukocyte uptake, should help avoid interpretational confusion.

Key Words: indium-111 leukocyte; technetium-99m sulfur colloid; osteomyelitis; Paget's disease

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Although labeled leukocyte imaging is one of the most specific modalities for detecting acute infections and specifically osteomyelitis (*1*), false-positive results are known to occur in a variety of conditions. These include sites of noninfected active bone marrow (*2,3*), recent fractures (*4*), tumors (*5*), hematomas (*6*), charcots joints (*7,8*), rheumatoid arthritis (*9*) and others (*4*). Bone marrow scanning has been used with increasing frequency to differentiate osteomyelitis as a reason

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FIGURE 1. Indium-111-leukocyte scan shows foci of radiotracer accumulation in the region of the right sterno clavicular joint, humeri bilaterally, left femur diffusely, distal end of the right femur, proximal one-half of the right tibia and, to a lesser extent, the proximal one-half of the left tibia. The spleen incidentally appears to be enlarged.

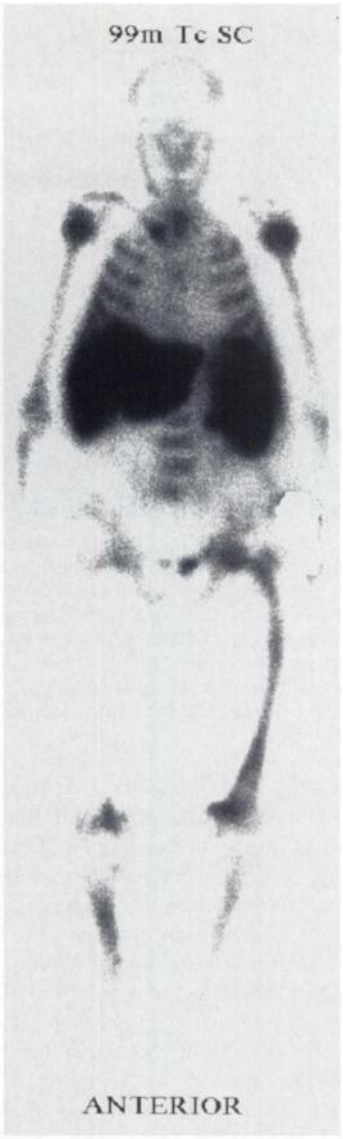

FIGURE 2. Technetium-99m-sulfur colloid bone marrow scan revealed essentially identical findings to those seen on ^{111}In-leukocyte scan, indicating ^{111}In-leukocyte accumulation at sites of expanded bone marrow rather than due to infection.

for increased labeled leukocyte uptake from bone marrow uptake (*2,3*) as significant variability and alterations of bone marrow is known to be present particularly following surgery and trauma (*10*).

We present a patient with long-standing and extensive Paget's disease, who showed abnormal and unusual pattern of accumulation of ^{111}In-white blood cell (WBC) which simulated osteomyelitis at some sites. This was later proven to be due to expanded active bone marrow uptake at pagetic bones. Sites of Paget's disease in this patient showed a spectrum of various degrees of ^{111}In-WBC and ^{99m}Tc-sulfur colloid uptake, probably related to the various phases of the disease.

CASE REPORT

An 83-yr-old man was referred for an ^{111}In-WBC study to rule out osteomyelitis of the right femur. The patient has a recent history of fracture of the mid/distal ⅓ of the right femur, after a trivial twist while getting down from his bed 6 wk earlier. Following the trauma, the patient had an open reduction and insertion of multiple metallic screws. The patient continued to complain of pain as well as fever of 102°F and leukocytosis for 3 wk which was refractory to antibiotics. The patient was known to have diffuse Paget's disease of the bone; hepatic cirrhosis with ascites and esophageal varices; congestive heart failure; and a past history of aortic valve replacement and coronary artery bypass surgery.

Relevant laboratory findings included: leukocyte count of 11,700–13,200/cu mm with 81% neutrophils, 9% lymphocytes, 8% monocytes, 1% eosinophils and 0.5% basophils; hemoglobin of 11.2–12.2 gm/dl (normal 13.9–16.3); alkaline phosphatase of 551 U/liter (normal 30–110); and creatinine of 1.6 (normal 0.7–1.7).

An ^{111}In-WBC scan was performed 24 hr following intravenous administration of 481 μCi ^{111}In-labeled autologous leukocytes. Anterior and posterior whole-body images were obtained. The study (Fig. 1) revealed an abnormal accumulation of activity in the regions of right sternoclavicular joint, humeri bilaterally, left femur diffusely, distal end of the right femur, proximal forearms, proximal right tibia and, to a lesser extent, proximal ½ of the left tibia. Decreased to absent uptake in the sternum and right hemipelvis was also seen. Incidentally, the spleen appeared enlarged secondary to the patient's known cirrhosis.

Although the scan was negative for osteomyelitis at the area of the fracture and uptake by expanded bone marrow was suspected, osteomyelitis could not be excluded, particularly at sites of focally increased uptake of labeled leukocytes as in the right sternoclavicular region. Therefore, a bone marrow imaging study was subsequently obtained the same day after an intravenous injection of

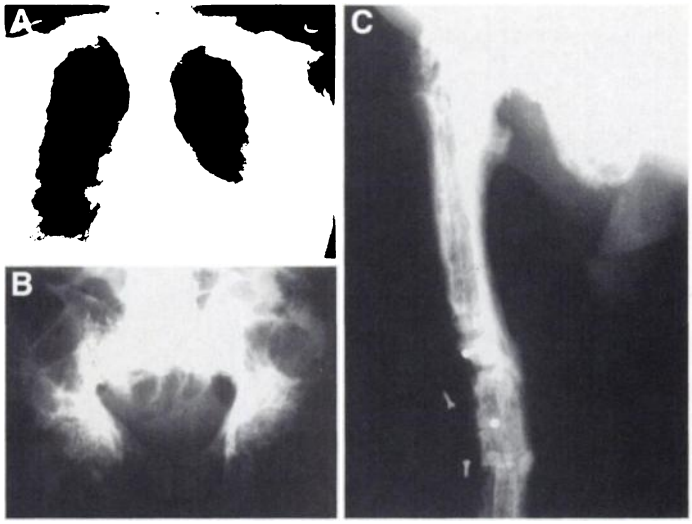

FIGURE 3. Representative bone radiographs. Chest radiograph (A) obtained 3 wk before the ^{111}In-WBC study reveals diffuse sclerosis of bones including clavicles. Coarsened trabeculae are noted in the left humerus. These findings were consistent with the patients' known Paget's disease. Standard radiographs of the pelvis (B) and right femur (C) demonstrate diffuse cortical thickening and mottling with some bone enlargement, changes that are compatible with the patients' known Paget's disease. There is deformity of the right femur with displaced fracture of the mid/distal third of the femoral shaft with metallic screws within the soft tissue.

10.5 mCi ^{99m}Tc-sulfur colloid (Fig. 2). The scan revealed identical findings to those seen on the ^{111}In-leukocyte scan, which indicated active bone marrow uptake rather than infection. Radiograph of the chest, pelvis and lower extremities (Fig. 3) were reviewed. The radiographs revealed diffuse sclerosis of many bones, including the right clavicle, humeri, femura and pelvic bones secondary to the patient's known extensive Paget's disease. Correlation between the diffuse Paget's disease and scintigraphic findings of a spectrum of ^{111}In-WBC and ^{99m}Tc-sulfur colloid bone marrow uptake was also seen on the radiographs. Foci, such as the right clavicle and left femur, showed increased ^{111}In-WBC uptake corresponding to ^{99m}Tc-sulfur colloid uptake. The right femur and sternum, however, revealed no uptake by both ^{111}In-WBC and ^{99m}Tc-sulfur colloid. Tibiae and pelvic bones showed mixed patterns of uptake of both radiopharmaceuticals.

Osteomyelitis accordingly was not felt to be present in this patient and various phases of the known Paget's disease explained the ^{111}In-leukocyte uptake. The patient was found to have spontaneous bacterial peritonitis proven by purulent ascitic fluid that contained 110–800 WBC/cu mm on multiple aspirations and on culture grew *Streptococcus MG Intermedius*.

DISCUSSION

The skeletal distribution of Paget's disease suggests that the disease predominates in bones containing red marrow and may be dependent on the blood supply (*11*). Normal hematopoietic bone marrow may be replaced by loose fibrous connective tissue. With time, the increased osteoblastic and osteoclastic activity ceases, and marrow abnormalities return to normal and the affected bones become sclerotic (*11*).

Normally, the entire fetal marrow space is essentially occupied by red (hematopoietic) marrow at birth. Conversion from red-to-yellow nonhematopoietically active-marrow starts in the immediate postnatal period. This process first starts in the extremities and progresses generally from peripheral-to-central skeleton and from diaphyseal-to-metaphyseal regions in individual long bones. By approximately the age of 25 yr, marrow conversion to adult pattern is usually complete (*12*). In adults, hematopoietic bone marrow is confined to the skull, vertebrae, ribs, sternum, pelvis and proximal portions of humeri and femura (*12*). Fatty marrow in other bones may, however, contain islands of hematopoietic tissue and a pattern of normal adult hematopoietic marrow can show variations (*10,12*). Alterations of normal pattern due to a variety of reasons including surgery, trauma and infections is also known to occur (*10*). With increasing demand for red cells, reconversion of yellow-to-red marrow may take place. This process follows the reverse order of the initial red-to-yellow marrow conversion. This reconversion accordingly starts in the axial skeleton followed by extremities from proximal to distal (*12*).

TABLE 1
Comparison of Indium-111-WBC scan with Technetium-99m-Sulfur Colloid Bone Marrow Scan and Standard Radiograph Findings

Site	^{111}In-WBC	^{99m}Tc-sulfur colloid	Radiograph
Sternum	Absent uptake	Absent uptake	Paget's disease
Right clavicle	Focal uptake	Focal uptake	Paget's disease
Left clavicle	Absent uptake	Absent uptake	Paget's disease
Humeri	Diffuse uptake	Diffuse uptake	Paget's disease
Left femur	Diffuse uptake	Diffuse uptake	Paget's disease
Right femur (except distal end)	Absent uptake	Absent uptake	Paget's disease
Distal right femur	Focal uptake	Focal uptake	Paget's disease
Tibiae	Focal uptake	Focal uptake	Paget's disease
Pelvis	Partly absent uptake	Partly absent uptake	Paget's disease

The pattern of marrow distribution in our case is rather irregular with different patterns of uptake and is not the usual for marrow expansion secondary to red cell demand. Additionally the patient is not known to have any significant or chronic anemia or other hematopoietic disorders to explain the marrow expansion and replacement.

Many of the sites of Paget's disease in this case showed accumulations of ^{111}In-WBC and ^{99m}Tc-sulfur colloid bone marrow uptake (Table 1). The right femur, sternum and left clavicle that are affected by Paget's disease showed, however, absent uptake on both studies. Involved tibiae and pelvic bones also showed variable degrees of uptake of both radiotracers.

Paget's disease begins with active resorption (lytic phase) which may progress rapidly and results in softening of bone. Pathologic fractures particularly of the femur and tibia frequently occur. At this phase the bone trabeculae are slender and very vascular. Giant osteoclasts are present and were shown to take up ^{67}Ga (*13*). This phase is followed by a mixed phase that is characterized by accelerated formation as well as resorption of bone. If bone formation predominates, this can be called osteoblastic phase and the term mixed can be reserved to those with approximately equal resorption and formation (*14*). The final phase (the sclerotic or burned-out phase) is characterized predominantly by new bone formation, more disorganized structure, thick trabeculae and less prominent vascular sinusoids. The disease is often nonuniform within the skeleton and individually involved bones can simultaneously contain more than one stage of the disease process reflecting variations of the duration of the disease at different sites (*14*).

This case demonstrates a mixture of absent and expanded bone-marrow uptake in areas of Paget's disease. This can be explained by areas of advanced, sclerotic disease with active bone marrow and areas of earlier active disease with replaced bone marrow. The ^{111}In WBC, being taken up by hematopoietic

bone marrow, is therefore seen in areas of Paget's disease with active marrow. This can mimic uptake of infection particularly when it is focal. Our case further demonstrates that clinico-radiographic information was crucial in this patients' scintigraphic management. The patients' medical history and radiographic findings raised the suspicion of Paget's disease as a cause of this patient's ^{111}In-WBC uptake pattern and led us to obtain a bone marrow scan to confirm it.

Photopenic areas in leukocyte imaging have been reported in traumatic, surgical or irradiation injuries, vascular necrosis, infection, neoplastic replacement, aging, fibrosis and Paget's disease (*15–17*) because of loss of normal marrow in these conditions. Accumulation of ^{111}In-WBC by Paget's disease, however, is rarely reported (*18,19*). Additionally, Paget's disease cases studied with sulfur colloid bone marrow scans showed decreased to absent marrow uptake as the marrow is replaced by fibrous tissue (*20–22*). Increased marrow uptake was only found in 1 of 21 pagetic bone reported in an abstract (*22*), and the extent of uptake is not known.

CONCLUSION

In patients with suspected osteomyelitis, particularly the elderly, abnormal ^{111}In uptake could be due to active bone marrow uptake in Pagetic bone. If ^{111}In-WBC uptake is suspected to be due to Paget's disease, correlation with a bone marrow scan should be considered, to avoid interpretational confusion.

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Technetium-99m-Pertechnetate Uptake by Intrathyroidal Parathyroid Adenoma

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A 57-yr-old woman was referred for preoperative scintigraphic localization of a parathyroid adenoma. Double-phase ^{99m}Tc-sestamibi imaging was performed followed by a separate-day [^{99m}Tc]pertechnetate thyroid scan. There was marked accumulation of both tracers by a right lower pole "thyroid" nodule which, at surgery, proved to be an intrathyroidal parathyroid adenoma. Hypervascularity is the presumed explanation for rare cases of pertechnetate-avid parathyroid adenomas.

Key Words: hyperparathyroidism; technetium-99m-pertechnetate; thyroid scans

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Nuclear scintigraphy is a well-established technique for the preoperative localization of parathyroid adenomas (*1–3*). Most imaging protocols rely on a dual-tracer subtraction technique using a perfusion tracer such as ^{201}Tl-thallous chloride or more recently ^{99m}Tc-sestamibi and a thyroid tracer ^{99m}Tc-pertechnetate or ^{123}I (*4–10*). It is generally observed that the parathyroid adenoma exhibits hyperperfusion but does not trap thyroid-specific iodine analogues, permitting the parathyroid adenoma to be differentiated from the thyroid on the subtraction image. We report a case in which a parathyroid adenoma exhibiting marked uptake of [^{99m}Tc]pertechnetate was erroneously thought to be a hyperfunctioning thyroid nodule.

CASE REPORT

A 57-yr-old woman was found to have persistent hypercalcemia following an episode of pancreatitis. Her serum calcium ranged from 2.92 to 3.15 mmole/liter (normal 2.10–2.60) with

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