
Hematogenous Pyogenic Vertebral Osteomyelitis: Diagnostic Value of Radionuclide Bone Imaging

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Hematogenous pyogenic vertebral osteomyelitis (HPVO) continues to be a diagnostic problem for clinicians due to nonspecific presentation of the disease (1,2). We reviewed our experience of the last 10 years to determine the diagnostic usefulness of radionuclide bone studies in this disease. We found 15 patients whose primary diagnosis was HPVO. Of the 15 patients, 12 had [^{99m}Tc]MDP bone scans which were all positive. Five of the 12 patients had positive [⁶⁷Ga]citrate scans and one patient with chronic active HPVO had negative ⁶⁷Ga and [¹¹¹In]WBC bone images. At the same time, three patients' spine x-rays and one patient's CT scan of the vertebra were normal. Additionally, in three patients spine x-rays were interpreted as consistent with degenerative joint disease that contributed to the delay of the diagnosis. We conclude that when HPVO is suspected an abnormal [^{99m}Tc]MDP bone image increases the probability of the disease, even if the x-rays and CT scans of the spine are normal. An abnormal ⁶⁷Ga image following an abnormal ^{99m}Tc bone image increases the specificity of the diagnosis. Normal [^{99m}Tc]MDP and [⁶⁷Ga]citrate bone images of the vertebra virtually exclude the diagnosis of HPVO.

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The diagnostic value and relative merits of radionuclide bone imaging techniques in nontuberculous, hematogenous, pyogenic vertebral osteomyelitis (HPVO) have not been well established (1). The initial, nonspecific clinical presentation of this disease may result in frequent misdiagnosis, long treatment delays, unnecessary surgery and, in some cases, permanent neurological damage or death (2,4). A highly sensitive screening procedure designed for infectious bone disease would greatly enhance the diagnostic capabilities of the clinician, and radionuclide bone imaging has the potential to fulfill this requirement.

This article is concerned with the role of radionuclide imaging in the diagnosis of 12 HPVO patients treated at this institution.

MATERIALS AND METHODS

Between 1974 and 1984, hospital records revealed 15 patients with a confirmed diagnosis of HPVO. The

diagnosis was established on the basis of the following three criteria: (a) a clinical presentation consistent with HPVO; (b) isolation of bacteria from blood cultures or from a biopsy of the vertebral lesion, and (c) with radiographic confirmation of vertebral involvement consistent with HPVO.

Vertebral osteomyelitis resulting from contiguous spread of infection from neighboring structures, severe trauma to the vertebra, infectious complications of disk surgery, or enzyme injections are excluded from this series. "Diskitis," a benign disease in children of uncertain etiology is also excluded.

Of the 15 patients, 12 patients had total-body bone scans which were performed on a scintillation camera using 20 mCi of technetium-99m-labeled methylene diphosphonate ([^{99m}Tc]MDP). Six of these patients also had total-body gallium-67 (⁶⁷Ga) scans, using 5 mCi of [⁶⁷Ga]citrate. One patient had an indium-111-labeled white blood cell ([¹¹¹In]WBC) image of the whole body. In two patients bone flow and immediate blood-pool images were obtained in association with bone scans. All 12 patients had multiple x-rays and tomograms of the spine during the course of the disease. Three of the patients had computed tomography (CT) scans of the

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vertebra. Three of the patients had lumbar contrast myelography. All 12 patients had multiple blood cultures during the course of the disease. Four patients also had a needle biopsy of the vertebral lesion.

RESULTS

Age and Sex

There were eight female and four male patients with the ages ranging 12 to 77 yr (mean 60 yr).

Predisposing Factors

Three of the patients had adult-onset diabetes mellitus; one male patient had urinary tract instrumentation 1 wk before back pain started; one male patient had a history of twisting trauma to his low back; a 13-yr-old female patient had acute tonsillitis and three patients had pyogenic abscess remote from the vertebra prior to admission.

Presenting Symptoms and Signs

The initial presenting symptom was back pain, with or without fever, in seven patients (58%). Abdominal pain in two patients (17%) and chest pain in two patients (17%) were the initial presenting symptoms. One patient described pain in the back of the leg similar to sciatica pain. Temperature was elevated to 38°C or above in nine patients (75%) and was normal in three patients (25%). The average duration of complaints was 4 wk and ranged from 2 days to 1 yr prior to the hospital admission. Two of the patients who initially complained of abdominal pain underwent laparotomy and cholecystectomy with negative results. In two of the patients, vertebral osteomyelitis of the thoracic ver-

tebra was discovered during a workup for cardiac disease.

Laboratory Results

The erythrocyte sedimentation rate (ESR) was elevated in 11 patients (100%) on whom the test was performed.

Serum alkaline phosphatase (alk. phos.) levels were elevated in seven patients (64%), normal in three (27%), and not performed in two patients.

White blood cell counts (WBCs) were elevated above 10,800 level in nine patients (67%) and normal in four patients (33%). All 12 patients had left shifts (100%) in differential WBCs, even though four patients had normal WBCs (Table 1).

Bacteriologic Results

Staphylococcus aureus was recovered in all three successive blood cultures in ten patients; *E. coli* in one patient; and group B streptococcus in one patient (Table 1).

Radiographic Results

Lumbar spine and thoracic spine x-rays obtained on the initial workup were consistent with HPVO in six patients (50%). Noted abnormalities consisted of narrowing of the disk space, sclerosis or erosion in the endplates, or destruction of the vertebral body (Fig. 1). In three patients (25%), spine x-rays and tomogram findings were consistent with degenerative arthritis (Fig. 2). In three patients (25%), spine x-rays and tomograms were normal in the initial course of the disease.

Computed tomographic scans were performed in three patients, two of which revealed a destructive process of the vertebral body in two patients (Fig. 3D). One

TABLE 1
Laboratory and Bacteriologic Results and Radionuclide Images

| Patient no. | Age (yr) | Sex | WBC [†] | Body temp. (°C) | SED [‡] | Alk Phos [§] | [^{99m} Tc]MDP | ⁶⁷ Ga | X-ray |
|-------------|----------|-----|------------------|-----------------|------------------|-----------------------|-------------------------|--------------------|--------|
| 1 | 77 | M | 15,000 | 38° | 61 | 189 | L5 [¶] | + | DJD** |
| 2 | 73 | M | 18,000 | 38° | 54 | 78 | L4-5 | + | Normal |
| 3 | 59 | F | 11,600 | 37° | 59 | 80 | T10 ^{**} | N/A | + |
| 4 | 13 | F | 13,000 | 39° | 41 | — | L2 | N/A | Normal |
| 5 | 40 | M | 8,800 | 37° | 48 | — | T11 | N/A | + |
| 6 | 71 | F | 19,400 | 40° | 60 | 244 | T12-L1 | Neg. ^{††} | DJD |
| 7 | 62 | F | 20,000 | 38° | 67 | 105 | T6 | N/A | Normal |
| 8 | 61 | F | 10,000 | 38° | 57 | 111 | L3-4 | N/A | + |
| 9 | 68 | F | 11,000 | 39° | 58 | 80 | L3-4 | + | + |
| 10 | 70 | F | 18,200 | 39° | 55 | 208 | T8 | + | + |
| 11 | 61 | F | 15,000 | 38° | — | 127 | T12 | + | DJD |
| 12 | 65 | M | 9,000 | 37° | 55 | 176 | T6 | N/A | + |

[†] WBC: White blood count (normals: 4,300–10,800/cubic mm).

[‡] SED: Erythrocyte sedimentation rate (normals: Males 1–13 mm/hr; Females 1–20 mm/hr).

[§] Alk phos: Serum alkaline phosphatase (Normal adults: 13–98 μ/l).

[¶] L: Lumbar vertebra.

^{**} T: Thoracic vertebra.

^{††} [¹¹¹In]WBC image was also negative.

^{**} DJD: Degenerative joint disease.

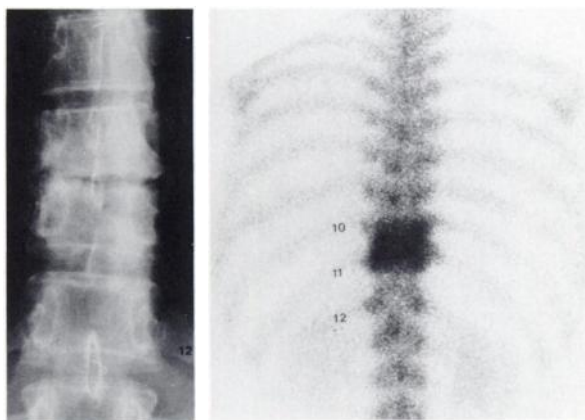


FIGURE 1
Early changes in lower thoracic spine x-ray due to vertebral osteomyelitis (left); increased radiotracer activity in phosphate bone image (right)

of these CT scans indicated a paravertebral abscess (Fig. 3D). In one patient the CT scan was normal.

Ultrasound studies were performed on two patients to investigate the paravertebral region for suspected paravertebral abscesses; both studies were within normal limits.

Contrast myelograms were performed on four patients with neurological findings. In two patients myelograms revealed an epidural abscess which necessitated surgical draining.

Radionuclide Images

All 12 patients had an abnormal [^{99m}Tc]MDP total-body bone scan (100% sensitivity). Abnormalities were located in the lumbar vertebrae in five patients (42%); in the thoracic vertebrae (Fig. 3) in six patients (50%); and in T12-L1 in one patient.

Eleven patients had involvement of only one vertebra (92%), and the remaining one patient (8%) had abnormalities in two adjoining vertebrae. The pattern of uptake was diffuse in the vertebral body and, when there was a paravertebral abscess, the uptake extended laterally into the paravertebral region, as occurred in two patients (Fig. 3).

In one patient with acute HPVVO a bone flow study and postflow blood-pool images showed increased flow and increased uptake, respectively, coinciding with the abnormality seen on the [^{99m}Tc]MDP bone scan. The flow study and postflow blood-pool images were normal in a patient with chronic active osteomyelitis.

In five of six patients, ^{67}Ga scans showed increased uptake corresponding to abnormal regions of [^{99m}Tc]MDP bone scans. The intensity of uptake of ^{67}Ga was equal to the intensity of [^{99m}Tc]MDP in the bone images; and when a paravertebral abscess was present, the uptake of gallium extended laterally beyond the bone margins into the paravertebral space (Fig. 3A). In one, the patient with chronic active osteomyelitis, ^{67}Ga and [^{111}In]WBC images were normal.

DISCUSSION

Hematogenous pyogenic vertebral osteomyelitis has been described as a condition termed "the great masquerader" (4-6). The classic symptoms of local vertebral tenderness, back pain, fever, chills, and general malaise either are not present or are often confused with chronic illnesses commonly found in the elderly. Delays in the diagnosis and treatment could result in serious neurological complications, as occurred in two of our patients, or in high mortality (7,8).

The most common predisposing conditions are uremia, cancer, urinary tract infection or instrumentation,

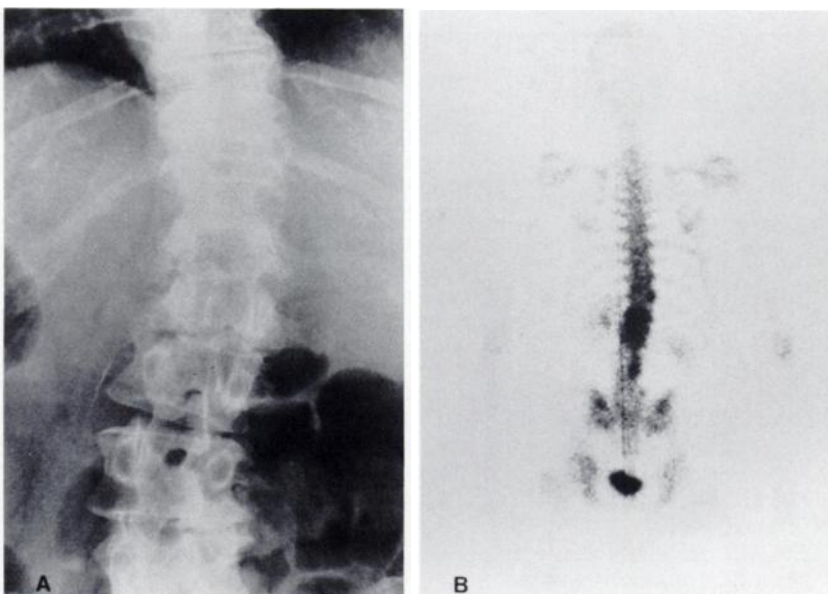


FIGURE 2
A: Severe x-ray changes in vertebra due to vertebral osteomyelitis, and arthritis which posed problems in interpretation. B: Bone image of same patient

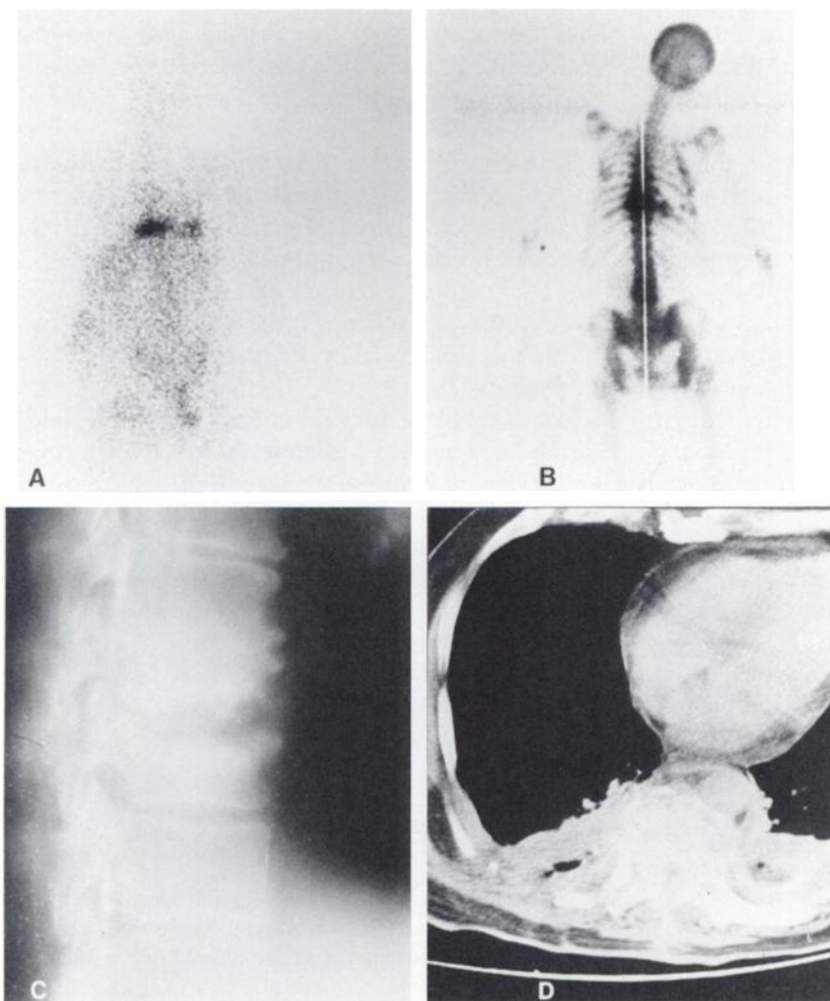


FIGURE 3
Patient with acute HPVO with para-vertebral abscess. A: Posterior ^{67}Ga image. B: Bone image. C: Spine x-ray. D: CT scan of vertebra

diabetes, drug abuse, and bacterial endocarditis (9-14). Specifically, diabetic patients are more susceptible to the disease and to permanent neurological sequelae resulting from infection than are nondiabetics (15). The disease is commonly diagnosed in adults over 50 yr of age. However, there is a less prominent peak of incidence at ages 10-19 yr (7). The reported series in the literature indicates a 2:1 male preponderance (7) in contrast to a 2:1 female preponderance that we found in our series.

Initial clinical symptoms are nonspecific. In a reported review of HPVO (7), only 50% of the patients were found to complain of back pain during the initial examination. In our series, back pain was present in 58% of the patients. High temperatures, above 40°C , are seldom recorded; chills are not observed often; fever and elevated WBCs may not be present in patients with chronic active osteomyelitis. Despite normal WBCs, a left shift was present in differential WBCs. ESRs were uniformly elevated, including patients with chronic active osteomyelitis, ranging between 50-77 mm/hr.

In an elderly patient a combination of findings of a predisposing condition, back pain, point tenderness

over the vertebra, elevated sedimentation rate, fever, and elevated WBCs strongly suggests vertebral osteomyelitis and provides the justification to obtain a radio-nuclide bone image, even if the x-rays and CT scan of the vertebrae were reported as normal (Table 1).

The imaging modalities commonly available to study infectious bone disease in nuclear medicine are the three-phase bone scan using [$^{99\text{m}}\text{Tc}$]MDP (16), the ^{67}Ga scan (17), and the [^{111}In]WBC scan (18). In our hands the [$^{99\text{m}}\text{Tc}$]MDP bone scan was the most sensitive screening test. A normal [$^{99\text{m}}\text{Tc}$]MDP bone image virtually ruled out suspected acute or chronic active osteomyelitis. The sensitivities of the three-phase bone scan have been reported from 89% in osteomyelitis to 100% in vertebral osteomyelitis (19,20). The [$^{99\text{m}}\text{Tc}$]MDP bone scan specificity is 94%, and the overall accuracy is 92% in all spectra of osteomyelitis (19).

Sequential use of [$^{99\text{m}}\text{Tc}$]MDP and ^{67}Ga imaging modalities have been shown to improve image interpretation (21). In our series, in five patients with acute HPVO, [$^{99\text{m}}\text{Tc}$]MDP and ^{67}Ga scans were both positive. One patient who had chronic active HPVO had normal ^{67}Ga and [^{111}In]WBC scans.

Although all segments of the vertebrae, including the sacroiliac joints, could be involved with the disease (7), HPVO is most common in the lumbar vertebrae. In our series, the majority of patients displayed abnormalities in the thoracic vertebrae in contrast to the high number of lumbar vertebral involvement suggested in the literature (7). In two of our patients who experienced pain in the abdomen extensive workup for abdominal abscess resulted in laparotomy and cholecystectomy with negative results. The diagnosis was delayed for a period of 1 mo because of this workup. The diagnosis of HPVO was made when the patients began to complain of paralysis of their legs and difficulty in walking. In both cases, the initial changes in the spine x-rays were reported as degenerative arthritis, contributing to the delay of the diagnosis.

The pattern of uptake in an abnormal bone scan is not specific for HPVO. If the clinical presentation and the blood chemistry are consistent with HPVO and if the initial three-phase initial bone scan and subsequent ^{67}Ga scan, or [^{111}In]WBC scan, are positive then a more specific diagnosis of HPVO may be made on the basis of these radionuclide studies. The most common uptake pattern is a diffuse increased uptake in one or more vertebrae. However, areas devoid of activity were reported on ^{67}Ga or [^{111}In]WBC scans (24,25). We have not noticed "cold" regions in the affected areas of the vertebrae in our studies.

In patients with paravertebral abscesses, abnormalities on bone and gallium scans may extend into the paravertebral regions. The pattern of this uptake has been termed the "butterfly sign" (26).

The earliest changes in x-rays of the vertebrae are disk space narrowing and sclerosis of endplates of adjoining vertebral bodies, which is seen in 74% of patients (7,27). The oblique and the lateral views of the spine are essential to delineate the abnormalities on the tomograms (3,28). Demonstration of early sclerosis in the endplates of the vertebral bodies is a useful feature in differentiating between pyogenic and tuberculous spondylitis (29). In tuberculous osteomyelitis of the vertebrae, sclerosis usually occurs 6–9 mo later (7,29).

In the later stage of the disease, x-rays of the spine may show extensive destruction of the vertebrae and, in some cases, paravertebral abscess.

The presence of significant degenerative arthritis of the vertebrae may mask the early findings of HPVO. In 25% of our patients, the initial spine x-rays were consistent with degenerative arthritis, which contributed to the delay of diagnosing HPVO in these patients.

In the early stage of the disease, CT scans may be negative (30). Disk hypodensity has been reported as an early sign of vertebral osteomyelitis in CT scans (31). The CT scans at a later stage showed destruction of the vertebrae and were most helpful in delineating paravertebral abscess. Ultrasound examination has

been used to delineate paravertebral extension of the disease. When there is a sign of cord compression, myelograms are the most helpful technique to identify the level of epidural abscess.

Isolation of organism from either blood cultures or from biopsy material of the involve vertebra is an essential condition to make the diagnosis of HPVO. Several different organisms have been reported causing HPVO (7). *Staphylococcus aureus* is the predominant gram-positive organism. In our series *Staphylococcus aureus* was isolated as the cause of HPVO in 80% of the patients.

Identification of bacteria is not only important for the diagnosis but also is essential for effective treatment. Antibiotics are administered according to the sensitivity of the isolated organism to antibiotics. Without the recovery or isolation of causative organisms from biopsy material the diagnosis of HPVO is always in doubt.

We conclude that when HPVO is suspected, the initial workup should include radionuclide bone imaging including a three-phase [$^{99\text{m}}\text{Tc}$]MDP bone scan and ^{67}Ga or [^{111}In]WBC scan even if the radiological studies are normal. A negative bone scan indicates a low probability of HPVO.

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