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CT of Osteomyelitis of the Spine

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Computed tomography (CT) were performed in 17 adults with osteomyelitis of the spine. The dominant features were paravertebral soft-tissue swelling, abscess formation, and bone erosion. In two patients there were no findings indicative of osteomyelitis on conventional radiographs, but CT revealed paravertebral abscesses and bone lysis, helping to establish the diagnosis of osteomyelitis. CT was found helpful in the evaluation of the patients suspected of spinal osteomyelitis, chiefly because of its ability to detect early erosion of spongy vertebral bone, disk involvement, paravertebral soft-tissue swelling or abscess, and extension of the pathology into the spinal canal. Furthermore, CT facilitated closed-needle biopsy, helping to establish the pathologic diagnosis.

Osteomyelitis of the spine may be a difficult diagnostic problem. The clinical manifestations are often nonspecific, simply fever of unknown origin or septicemia, and there may be no localizing signs. The definitive diagnosis may be delayed for a number of weeks until characteristic erosive bone changes become evident [1–6]. Conventional radiography may fail to reveal the initial vertebral involvement. In our experience, early detection of erosive changes of the spongy vertebral bone is usually not possible by conventional radiography. Computed tomography (CT), on the other hand, displays the anatomy of the spine in an axial plane, thus overcoming the problem of overlapping of bone surfaces, and in some instances may reveal otherwise undetectable bone erosion. CT is particularly suited for study of the paravertebral abscesses [7] and spinal canal abnormalities [8, 9]. We report our experience with 17 patients with osteomyelitis evaluated by CT during a 4 year period.

Materials and Methods

Seventeen adults (12 men and five women) were studied; they were 29–79 years old (mean, 54 years). Eight had tuberculosis and nine had pyogenic infections of the spine. Seven were habitual intravenous heroin users. One patient had urinary tract infection preceding the clinical onset of osteomyelitis. Another was on long-term corticosteroid treatment for rheumatoid arthritis. One patient was in a state of immunosuppression. Three patients were referred for CT examination because of fever of unknown origin. The 14 patients with clinically diagnosed osteomyelitis were investigated by CT to determine the extent of involvement of the soft tissues and spinal canal. The site of involvement was found to be in the lumbar spine in nine patients, lumbosacral in one, thoracic in six, and cervical in one.

The patients were studied on GE 8800 and EMI 6000 scanners. The area of interest was scanned with sequential 5-mm-thick slices. Four patients had follow-up CT examinations. Frontal and lateral conventional radiographs were available in all patients. Conventional tomography was performed in five patients.

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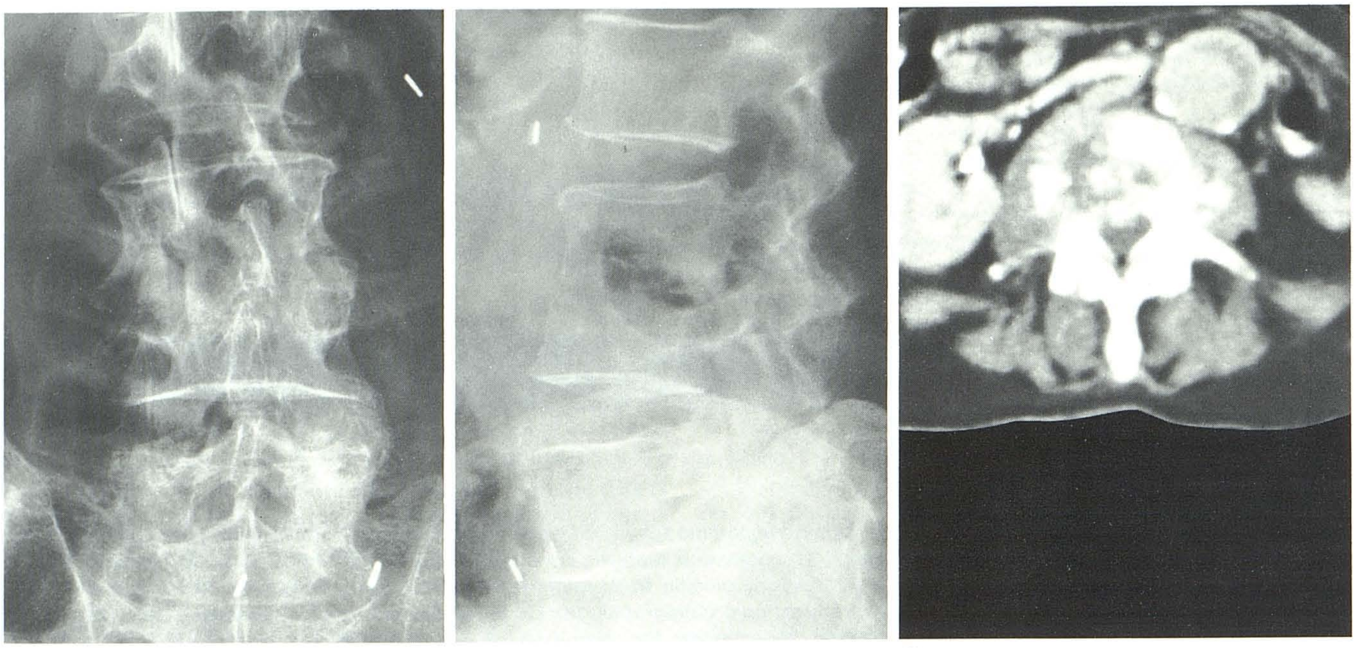


A B C

Fig. 1.—Case 1. Staphylococcal osteomyelitis L3–L4. S/P aortic graft surgery. Anteroposterior (AP) (**A**) and lateral (**B**) views of lumbar spine. Loss of L3–L4 disk space and destruction of adjacent vertebral end-plates. Clips in abdomen from previous graft surgery. **C**, CT of inferior aspect of L3 after oral and intravenous contrast. Destruction of vertebral body L3 with extension of bone detritus in anterior aspect of spinal canal. Soft-tissue mass containing calcifications in paravertebral space. Clear fat plane separates paravertebral soft-tissue swelling from aortic graft.

Results

In all patients, CT demonstrated paravertebral soft-tissue swelling. This was marked and was associated with psoas abscesses containing low-density necrotic loculations in four patients with tuberculosis and in one with pyogenic infection. None of these abscesses were detected by conventional radiographic methods. In one patient with pyogenic infection, CT demonstrated gas bubbles in a presacral abscess.

The extent of the trabecular bone destruction seen on CT was invariably greater than that estimated by conventional radiography. In two of the 17 patients there were no signs of osteomyelitis on conventional films, but CT revealed erosion of the cancellous bone of the vertebral bodies and loss of the cortical margin of the end-plates. In one patient with thoracic spine osteomyelitis CT revealed distinct destruction of the anterior cortex of the rib near the costovertebral joint, a finding not detected with other methods.

The narrowing of the disk space was at times difficult to notice on primary axial CT images. Reference to the lateral scout images and, in selected cases, sagittal and coronal reconstruction made this information easily noticeable.

CT demonstrated spinal canal involvement in two patients with posterior extension of the inflammatory mass and detritus of bone originating in an infected disk space. In another patient extension of the paraspinal abscess into the neural foramen was observed.

Follow-up CT in four patients demonstrated emergence of reactive osteosclerosis, calcification in the paraspinal abscesses, and a decrease in the soft-tissue swelling. The following three cases illustrate the importance of CT in the diagnosis and management of these patients.

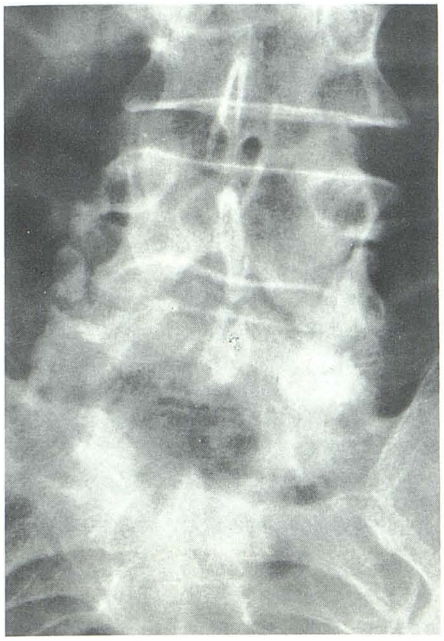
Representative Case Reports

Case 1

A 65-year-old man with previous graft replacement of an abdominal aortic aneurysm was admitted for intermittent fever of several weeks' duration and diffuse back pain. Repeated blood cultures were positive for *Staphylococcus aureus*. The initial diagnosis was septicemia, for which he received a variety of antibiotics. The continuous seeding of the bloodstream and lack of response to antibiotics were attributed to localization of the infection in the abdominal aortic graft. Physical examination was unremarkable, except for lumbar spine tenderness.

Radiographs of the lumbar spine demonstrated disk space loss at L3–L4 with destruction of the adjacent vertebral end-plates (figs. 1A and 1B). Abdominal CT demonstrated a normal aspect of the aortic graft. There was a paravertebral abscess containing calcific as well as low-density areas extending into the psoas muscle. A clear fat plane was seen separating the psoas abscess from the posterior wall of the aortic graft. Marked destruction of the vertebral body L3 was seen on CT, with extension of the bone detritus posteriorly into the spinal canal (fig. 1C).

Comment: CT was the optimal method to disclose the separation between the paravertebral abscess and the aortic graft. It added the information of posterior extension of the vertebral body destruction, with involvement of the spinal canal.



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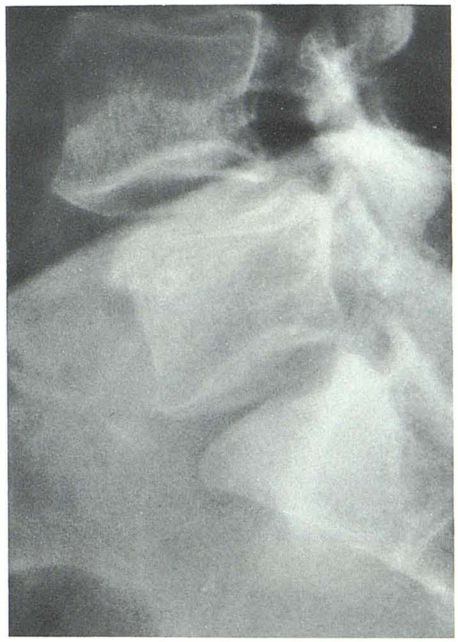

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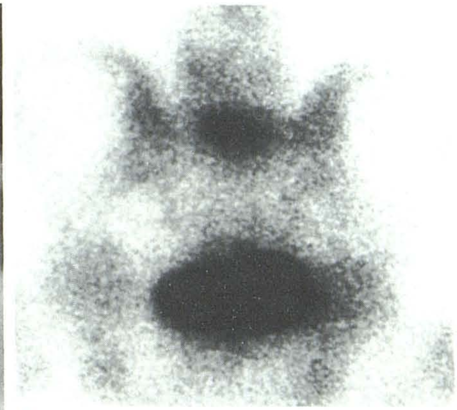

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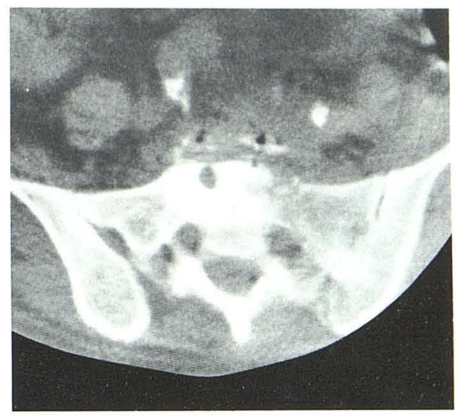

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Fig. 2.—Case 2. Pyogenic osteomyelitis L5–S1; perforated colon and presacral abscess. AP (**A**) and lateral (**B**) views of lumbar spine. Normal aspect of disk space L5–S1, degenerative disease in apophyseal joints, and grade I spondylolisthesis of L4 on L5. **C**, ^{99m}Tc-diphosphonate bone scan. Increased uptake at L5–S1 level. **D**, CT of superior aspect of sacrum. Presacral mass containing gas and scattered calcifications. Anterior cortical margin absent on left; cavity surrounded by bone sclerosis is in sacrum.

Case 2

A 78-year-old man was admitted for fever of 1 week's duration and diffuse low-back pain. No abnormality was found on physical examination.

Radiographs of the lumbar spine demonstrated grade I spondylolisthesis of L4–L5 and degenerative disease of the L4–L5–S1 apophyseal joints (figs. 2A and 2B). The L5–S1 disk space and the adjacent end-plates appeared normal. A ^{99m}Tc-diphosphonate bone scan showed increased uptake in the upper sacral segment (fig. 2C), and a ^{67}Ga-citrate scan demonstrated increased uptake in the same area. Conventional tomograms of L5 and S1 showed erosion of the cortical margin of the end-plates and destruction of the cancellous bone of the vertebral bodies. Repeated blood cultures grew a variety of microorganisms including *Streptococcus*, *E. coli*, *Aerobacter*, and *Bacteroides*. Over a period of 3 weeks the patient's general condition deteriorated despite parenteral treatment with broad-spectrum antibiotics.

CT of the abdomen and lumbar spine performed at that time revealed a gas-containing abscess located anterior to the L5–S1 disk cartilage, extending into the presacral space. The abscess contained scattered calcifications. Destruction of the anterior aspect of the sacrum was visible, with a sclerotic bone reaction surrounding a lytic lesion in S1 (fig. 2D).

The patient underwent an open drainage procedure, which disclosed an abscess centered around a toothpick protruding from the colon and extending to the L5–S1 disk space. After surgical curettage and drainage, the patient's condition improved dramatically. Follow-up CT demonstrated healing of the veretebral lesion and marked diminution of the soft-tissue swelling in the prevertebral space.

Comment: In this case the initial radiographs of the lumbar spine were deceptively negative for an infectious process. Although the conventional tomograms, the bone scan, and the gallium scan were positive, it was only by CT that an abscess was precisely localized in the prevertebral space, thus directing the surgical drainage.

Case 3

A 48-year-old chronically alcoholic man was admitted with a 2 week history of shortness of breath and fatigue. He denied having fever, chills, or back pain. Physical examination revealed clinical signs of aortic valve insufficiency. Despite multiple negative blood cultures, subacute bacterial endocarditis was suspected because of persistent low-grade fever and increased sedimentation rate. After 6 weeks of intravenous broad-spectrum antibiotic therapy, the patient's general condition had not improved and the fever persisted.

A CT examination was performed in search of the source of infection. It showed a large paravertebral abscess with multiple loculations of low density at T11 and T12 levels (fig. 3A). There was destruction of the inferior veretebral end-plate of T11 and the adjacent spongioid bone (fig. 3B). The soft-tissue abscess and the

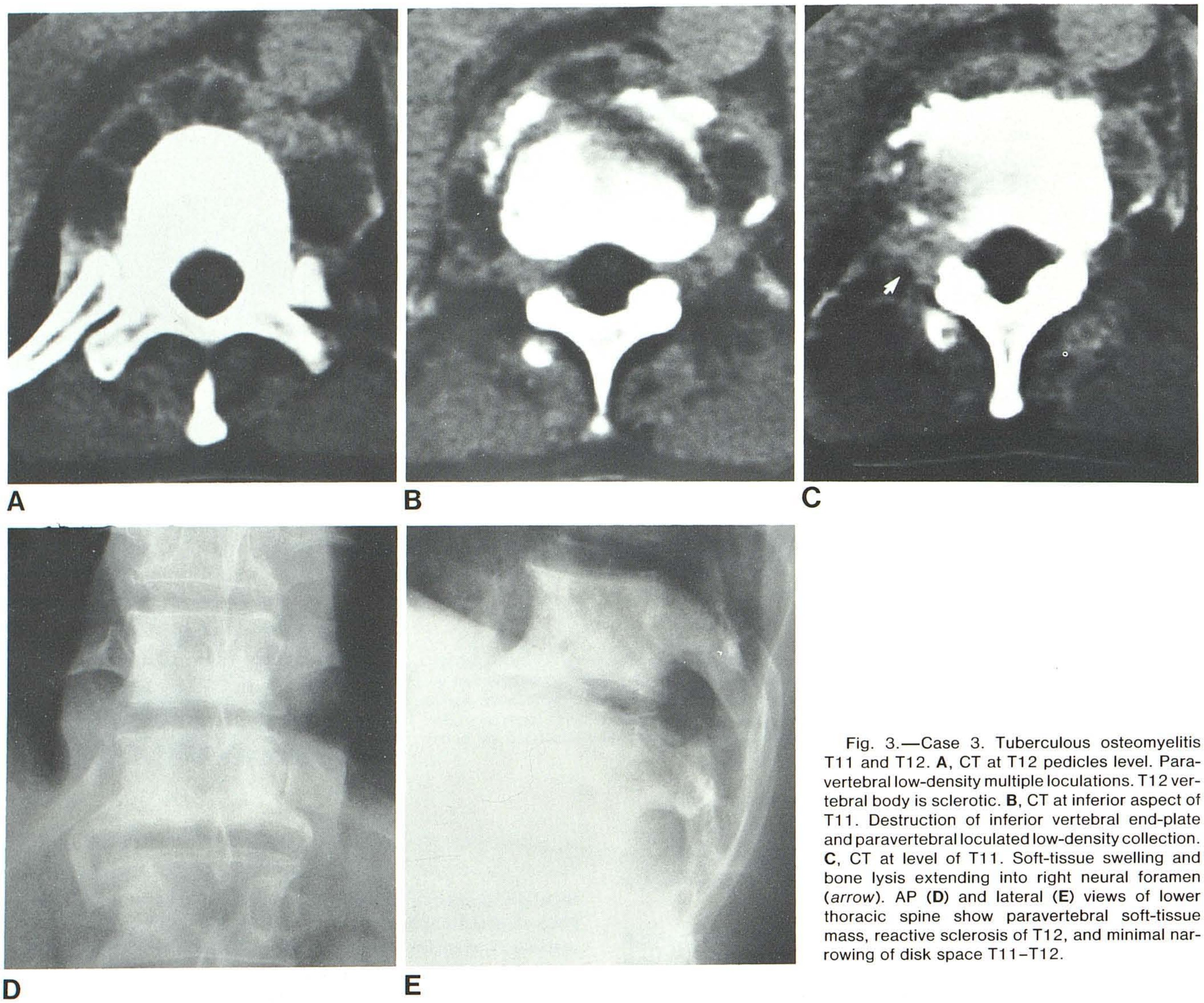

Fig. 3.—Case 3. Tuberculous osteomyelitis T11 and T12. **A**, CT at T12 pedicles level. Paravertebral low-density multiple loculations. T12 vertebral body is sclerotic. **B**, CT at inferior aspect of T11. Destruction of inferior vertebral end-plate and paravertebral loculated low-density collection. **C**, CT at level of T11. Soft-tissue swelling and bone lysis extending into right neural foramen (*arrow*). AP (**D**) and lateral (**E**) views of lower thoracic spine show paravertebral soft-tissue mass, reactive sclerosis of T12, and minimal narrowing of disk space T11–T12.

bone destruction extended into the right neural foramen (fig. 3C). Marked reactive sclerosis of bone was seen in the T12 vertebral body (fig. 3A). It was only at this point that conventional radiographic studies of the thoracolumbar spine were made. They revealed a paraveretebral soft-tissue mass, narrowing of the disk space T11–T12, and reactive bone production of T12 (figs. 3D and 3E). Needle aspirate of the paravertebral abscess grew *Mycobacterium tuberculosis*.

Discussion

Osteomyelitis has increased in frequency in the last 2 decades. This has been attributed to a number of factors, including the rise in drug addiction [1, 10, 11], use of intravenous indwelling catheters [1], and more aggressive urologic instrumentations in patients with urinary sepsis [3, 4]. In such instances, intermittent bacteremia presumably leads to hematogenous spread of the infection to the spine, with the initial focus of infection involving the spongy vertebral bone directly beneath the vertebral end-plate. This is probably due to the rich blood supply of this region [12]. Subsequently, the infection destroys the vertebral end-plate and invades the disk cartilage. Thus, involvement of the disk space may not become noticeable until significant vertebral erosion has occurred.

Extension of the infection from one vertebra to another without involvement of the intervening disk is seen more commonly in tuberculosis [2]. This is the subligamentous form of tuberculosis in which the infection extends beneath the anterior spinal ligament from one vertebral body to the next. The bone destruction in this form of the disease may be minimal, usually limited to the anterior surface of the vertebral bodies. However, paravertebral soft-tissue swelling and abscess formation may be extensive [2].

When osteomyelitis is suspected clinically, bone scanning (^{99m}Tc-diphosphonate) is useful for screening purposes, and it is positive in most patients [13]. Conventional radiography may reveal erosive changes of the cortex of the vertebral bodies and end-plates, but often only 2–6 weeks after the onset of the infection. Conventional tomography usually reveals these lesions at an earlier stage. However, erosion of the spongy vertebral bone beneath the vertebral end-plates, where infection may start, is often not detected in its early stages by conventional radiography or tomography.

CT, however, by virtue of its axial display, may reveal these changes when they are otherwise undetectable, as in two of our cases and in one of Lardé et al. [9]. Paraspinal soft-tissue swelling and abscess formation is usually seen in conventional radiographs of the thoracic region. However, in the lumbar and cervical segments, CT is by far the preferred method for this purpose. Intravenous contrast enhancement may help to accentuate the boundaries between abscess loculations and the adjacent uninvolved tissues. Thus, the true extent of paraspinal abscesses, particulary a psoas sheath abscess, is optimally demonstrated on CT [7]. This provides valuable information for drainage and constitutes an objective baseline for follow-up of these patients. CT is also helpful for a closed-needle biopsy of the infected disk space or the vertebra by revealing the most suitable site for biopsy as well as the safest and shortest route for needle passage [14, 15]. CT is also the method of choice for detection of involvement of the posterior arch of the vertebrae and extension of the infection into the spinal canal [9].

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