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Vertebral Osteomyelitis: Disk Hypodensity on CT

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The importance and role of computed tomography (CT) are discussed on the basis of 36 cases of vertebral osteomyelitis. The bone images themselves, the detection of lumbar disk hypodensity, and the exploration of soft paraspinal regions in the search for an abscess are factors that contribute to the superiority of this method in difficult cases. In cases where the diagnosis is already known, CT offers an excellent method to assess the extent of the lesions. Its accuracy, coupled with its rapidity and noninvasive nature, affects the role of conventional tomography, a method that is incomplete and involves higher radiation doses. CT offers an excellent method for follow-up after treatment of vertebral osteomyelitis.

Spinal osteomyelitis, both tubercular and pyogenic, is seen with some frequency in France where there is a large African immigrant population. Treatment is often exclusively medical, and it is effective only if diagnosis and identification of the causative organism are rapidly obtained, permitting prompt antibiotic therapy. The diagnosis of spinal osteomyelitis is most often based on the clinical findings and suggestive radiologic appearances. Nevertheless, the long delay between the development of anatomic lesions and their appearance on conventional radiographs, as well as the possibility of atypical findings, led us to investigate the contribution of early computed tomography (CT) to the diagnosis. At the lumbar level, one of the diagnostic signs that emerged was disk hypodensity; to our knowledge, this has not been previously reported. In addition, visualization of spinal abscesses and accurate monitoring of bone involvement represent additional contributions of this radiologic method.

Materials and Methods

During a 3 year period, 36 cases of spinal osteomyelitis were studied. Mean patient age was 42 ± 5 years with a range of 10–72 years. Twenty-eight examinations were performed as part of the initial diagnostic workup of the disease, including 14 lumbar localizations, 12 dorsal and two cervical. Criteria for the final diagnosis included appropriate clinical history, positive blood culture or positive disk/bone aspirate, and subsequent radiographic changes. Of these 28 cases, 12 were tuberculous (80% occurring in African subjects) and nine originated from *Staphylococcus* infections.

CT was performed for two different reasons: (1) for nine patients, the diagnosis of spinal osteomyelitis was unknown and CT was used as a primary diagnostic tool and, (2) in 19 cases, the radiologic diagnosis of spinal osteomyelitis was determined by conventional means and CT was used to assess the extent of the lesions, search for abscesses, and evaluate the posterior vertebral elements. In addition, eight CT examinations were performed for follow-up of known osteomyelitis or to evaluate a clinically suspected recurrence.

CT was performed with a Somatom Siemens SD with 4.5 sec scan time and instantaneous image reconstruction. The cortical and spongy vertebral bone and the intra- and paraspinal soft parts were successively analyzed. At the lumbar level, disk density was measured in the plane of an ideal section passing through the totality of the disk. All scans were thus

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obtained using contiguous 4 mm sections to avoid the effects of partial volume density increase caused by the vertebral end plates. We studied 80 normal subjects to estimate the normal density values of the lumbar disk and determined it at 73 ± 13 Hounsfield units (H) on a scale of 1000 H. At dorsal and cervical levels, the disk is too thin to allow any reliable density measurements. Most examinations were performed in two steps before and after the injection of a bolus of urographic contrast material (Telebrix 38, ioxitalamate meglumine and ioxitalamate sodium).

Results

Lumbar

Among the 14 lumbar localizations, CT was performed for primary diagnosis in four cases. In three of these, the diagnosis was determined by the finding of a hypodense disk (38 ± 2 H), whereas plain films showed only disk space narrowing. In all cases, disk hypodensity was associated with vertebral osteolytic lesions. In one case, disk density was normal in a instance of pure spondylitis in which the vertebral osteolytic lesions were revealed by CT (case 2). In these four cases, CT was also highly contributive to the diagnosis by the demonstration of extraspinal abscesses (four cases) and intraspinal abscesses (one case).

In 10 of 14 cases, the diagnosis of lumbar osteomyelitis was known or very probable on the basis of conventional plain films. CT appeared to be contributive to the examination of lesion spread by showing the existence of paraspinal abscesses in six cases and epidural extension in two cases. The analysis of bone lesions supplied no additional information. On the other hand, in nine cases, disk hypodensity could be found in the range of 30–45 H. This did not correlate with the specific organism. In the last case, no reliable disk measurement could be performed, the sections not being joined sufficiently.

Dorsal

Twelve dorsal localizations were explored with CT, and unique information was disclosed in four cases. These included demonstration of gas within an osteolytic focus (case 3) or reparative lesions invisible on standard films. In one case, osteomyelitis was fortuitously discovered during the workup of an osteitis of the sternum. In these four cases, there was a paraspinal abscess, however, this was already well seen on the anteroposterior view of the dorsal spine. CT analysis of disk density could not be satisfactorily performed in the thoracic spine because of partial volume effect in the narrow structure.

In the other eight cases of dorsal osteomyelitis, CT was performed to assess extension. In six cases, the examination furnished no additional information. Paraspinal abscesses existed in all the cases but had been seen on standard radiographs. In one case, CT showed a small epidural extension of the collection. In the last case there was involvement of the posterior arch, invisible on conventional radiographs.

Cervical

Only two cervical localizations were studied with CT. In one case, no additional information was provided. In the

other, in which the infectious process (actinomycosis) was situated at C1–C2, CT determined the exact extent of bone soft-tissue lesions.

Eight CT examinations were performed for follow-up of discovertebral lesions. In three cases, they were routine and comparative examinations, performed about 3 months after the first CT workup. In one case, unexpected extension of the osseous and soft-tissue lesions was encountered. In four cases, CT was indicated to confirm a clinically suspected recurrence. In two cases, an abscess was demonstrated. Two examinations were normal, and in one of them the demonstration of fatty tissue within vertebral body punched-out lesions led to the conclusion that they were inactive residua. Finally, in one observation, CT showed a narrow spinal canal complicating Pott disease related to vertebral block with dorsal kyphosis.

Representative Case Reports

Case 1

A 24-year-old man had a spiking fever for 3 weeks and lumbar pain. Erythrocyte sedimentation rate was 130 mm. The spinous process of L4 was tender to palpation. Radioisotope bone scan was negative. Conventional films showed a moderate narrowing of the L4–L5 disk space with no major alteration of the vertebral end plates (fig. 1A). CT showed osteolytic changes of L4 and L5 (figs. 1B and 1C) abscess of the right psoas muscle, and swelling in the right paraspinal muscular masses at L4 and L5 (fig. 1B). Disk density of L4–L5 was decreased at 38 H (fig. 1D), and L3–L4 density was normal at 70 H. Puncture of the posterior abscess, guided by sonography, led to isolation of *Staphylococcus*. Antibiotic treatment was rapidly positive with disappearance of fever and pain and return of the sedimentation rate to normal.

Case 2

A 24-year-old previously healthy man from Gabon was hospitalized for weight loss and low-grade fever. Cervical adenopathy had been present for 1 month, along with nonradiating low back pain. Examination revealed sacral tenderness and stiffness of the lumbar spine. Erythrocyte sedimentation rate was 75 mm.

Radiography showed possible minimal narrowing of the L4–L5 disk (fig. 2A), small spurs at L4–L5 and L3–L4, and minimal erosion of the left sacroiliac articulation. CT showed significant osteolytic changes of L4 and L5 (fig. 2B), spurs (fig. 2C) and suppurative collections in the prevertebral and presacral regions eroding the sacrum (fig. 2D). Disk densities of L3–L4 and L4–L5 were normal.

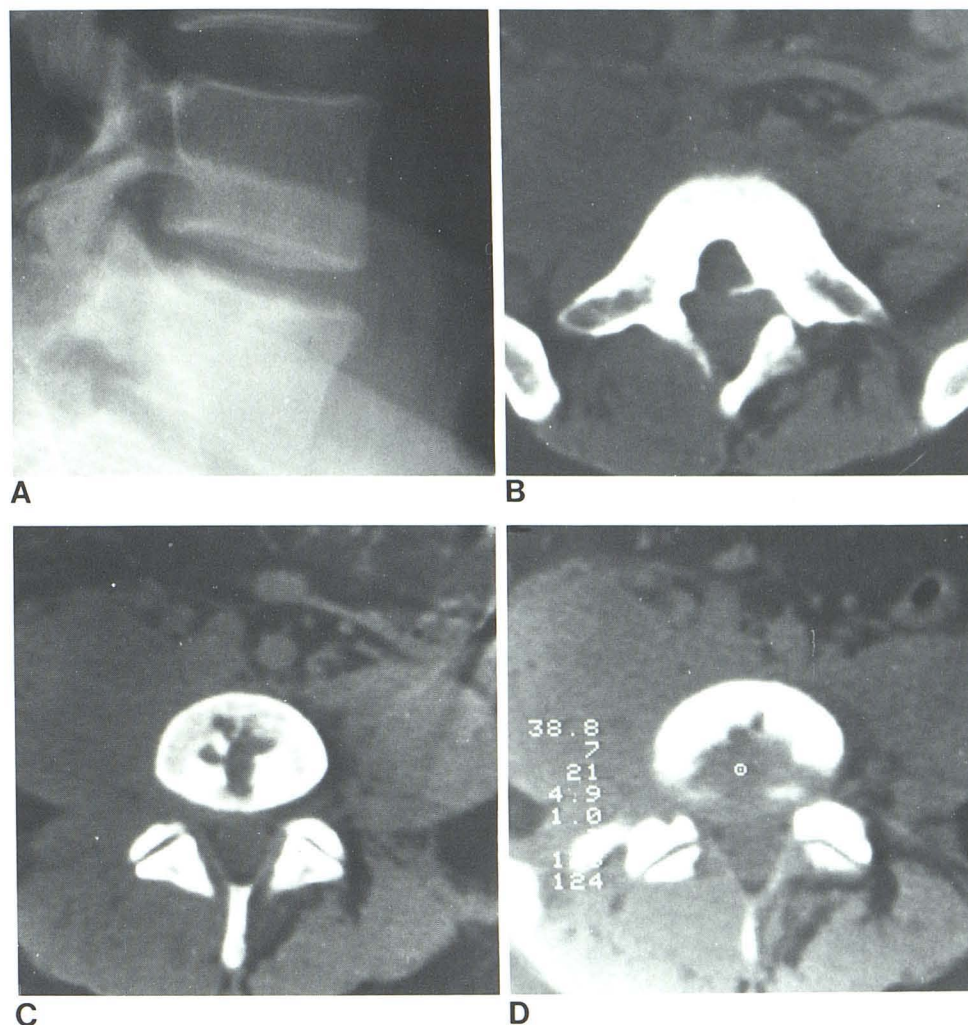
Needle biopsy culture confirmed the presence of *Mycobacterium tuberculosis* and antituberculosis treatment was started. His general state of health rapidly improved. Two months after the beginning of treatment, the erythrocyte sedimentation rate was 15 mm.

Followup CT 6 months later showed regression of the presacral abscess and consolidation of the discovertebral reconstruction lesions. Osteosclerosis and interbody bony spurs were present.

Case 3

A 66-year-old man had a spiking fever and dorsal pain for 3 weeks. He was suffering from Addison disease and had been treated for 2 years. Clinical examination was normal, except for a small dorsal kyphosis. Sedimentation rate was elevated at 45 mm. Radiographs and tomograms of the dorsal spine showed a marked anterior wedge-shaped collapse of T7 with a small osteolytic lesion

Fig. 1.—Case 1. Osteomyelitis, L4–L5 (*Staphylococcus*). **A**, Lateral view of lumbar spine. L4–L5 narrowing without visible bone destruction. **B**, Erosion of L5 posterior margin. Enlargement of right psoas muscle and swelling of posterior muscle masses with erosion of right lamina. **C**, Osteolysis of inferior vertebral end plate of L4 (resulting from mechanism of spread of infectious process). **D**, Disk hypodensity ($d = 38$ H).



of T8. Narrowing of T7–T8 disk was questionable. There was also paraspinal swelling, especially well visible anteriorly on lateral views (fig. 3A).

The CT examination surprisingly revealed several small gas collections within the osteolytic lesions (fig. 3B). The presence of a swelling of the soft parts suggested the diagnosis of osteomyelitis. Surgery of the lesions confirmed tuberculosis.

Discussion

Vertebral osteomyelitis initiated by direct extension is rare, and, in most cases, the bone is involved by hematogenous spread of organisms [2–7]. The first site of infection is the bone adjacent to the cartilage, a highly vascularized region [8–10]. This is well seen with CT at an early stage, when destructive lesions appear localized at this end plate (fig. 1C). The infectious process can remain localized at the vertebral body (fig. 2), but it usually involves the disk secondarily. This results in a narrowed intervertebral disk space, detectable radiographically 3–4 weeks after the initial septicemic phase.

The finding of disk hypodensity in the lumbar region is of particular interest, and would seem to relate directly to the abscess process. There is a potential error risk in disk

density measurements, however, because of the thickness of the structure studied relative to the thickness of the CT section (4 mm). Because of the partial volume effect, the risk would be to erroneously overestimate the measurement, thereby resulting in a false-negative interpretation.

We have never had a false-negative finding because the thickness of lumbar disk is sufficient to avoid any error using contiguous thin sections. This is not true at a more cephalic level or when the disk is completely destroyed. This disk hypodensity in three cases permitted diagnosis of an early osteomyelitis. In nine other cases in which the basic diagnosis was evident by plain films, we encountered disk hypodensity.

This hypodensity appears to be relatively specific, since we have never encountered it in any other pathology, especially degenerative in which density remains unchanged. In one patient with Hodgkin disease, this sign enabled us to reject the possibility of infectious process in favor of other discovertebral pathology. Surgery confirmed a focus of Hodgkin disease (fig. 4). In three other cases for which clinical context and radiography suggested an infectious process, the absence of disk hypodensity led to consideration of other pathologies (two intervertebral osteochondrosis, one metastasis).

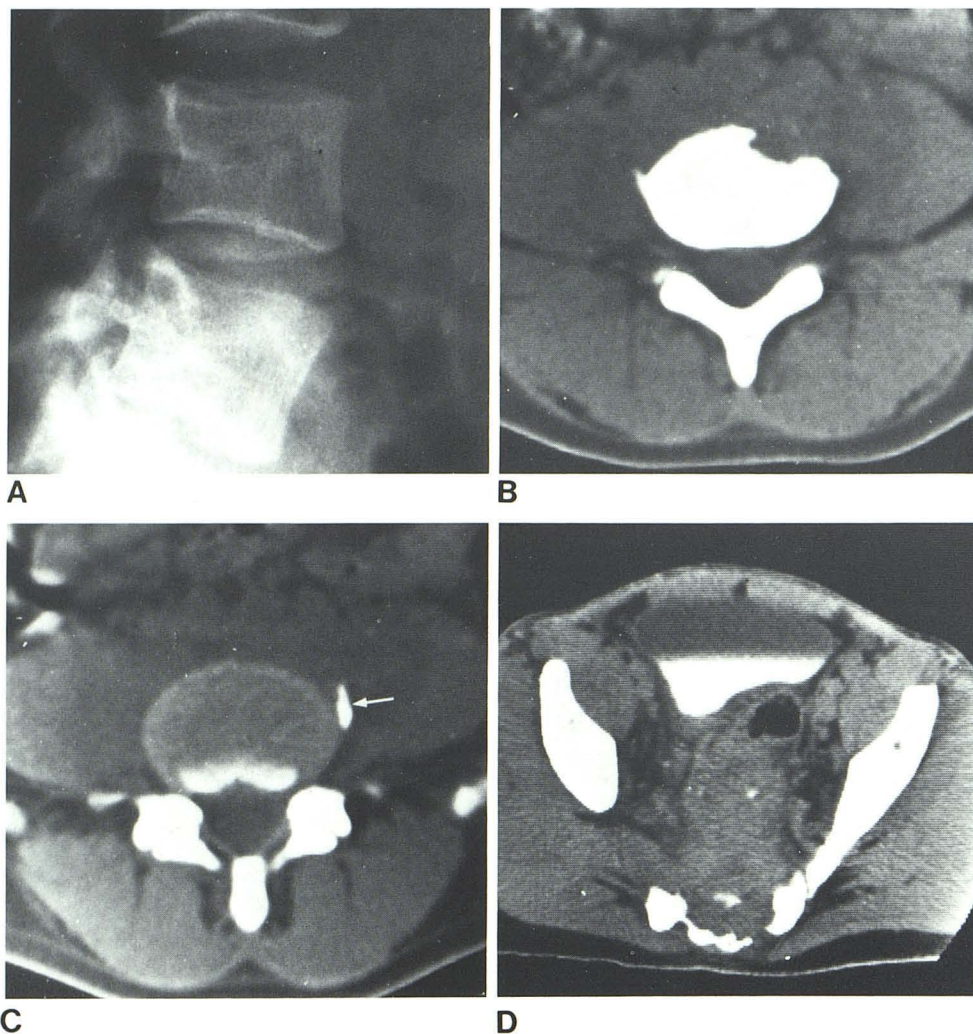


Fig. 2.—Case 2. Tuberculous spondylitis. **A**, Lateral view. Suspicion of minimal L4–L5 disk narrowing. **B**, Vertebral body osteolysis, especially visible on left anterolateral part of L4. **C**, Left L4–L5 interbody spur (arrow). Normal disk density (75 H). **D**, Paraspinal abscess with bulky presacral collection, osteolysis of sacrum, and displacement of sigmoid and bladder anteriorly.

Disk hypodensity could not be demonstrated in two osteomyelitis cases. In one case, reliable measurements were not possible since the sections had not passed through the disk material. In another instance (Case 2), there was multifocal tuberculous spondylitis without disk involvement. Radiologic follow-up 3 months later showed preservation of intervertebral spaces. CT appears to be very accurate in detecting intra- and extraspinal collections and in defining their limits. The administration of intravenous urographic contrast material can outline more clearly the hypodense areas corresponding to purulent collections within diffuse swelling of paravertebral muscles. Combining this with injection of any fistulous tracts may furnish additional information, especially for a preoperative workup.

The CT method is less useful at the level of the dorsal spine. Intervertebral disk measurements failed, probably because of the relative thinness of the disks. Demonstration of gas collections and reparative lesions may be decisive, but this circumstance remains exceptional. Similarly, CT is not needed for detection of soft-tissue extension at the dorsal spine level since the position of the paraspinal pleural reflection lines furnish a good landmark for detecting this

on conventional radiographs. Finally, the search for intraspinal abscesses remains fairly difficult without the injection of contrast media in the subarachnoid spaces. This is due to the paucity of epidural fat at the dorsal level, which is the natural contrast medium of the spinal canal. The problem at the cervical level is similar to that at the dorsal level. An exception would be the cervico-occipital joint, where CT may be useful for the study of bone lesions and the spread of purulent collections.

Among the 28 spinal osteomyelitis cases studied at initial stages of the disease, the presence of an abscess was visualized in 24 cases with four epidural extensions (fig. 5). Thirteen of the cases were of pyogenic, nontuberculous etiologies. The radiographic criteria of Murray and Jacobson [11], in which the presence of large paraspinal masses is more frequent in tuberculous lesions than in pyogenic osteomyelitis, may now have to be modified.

In three observations, CT showed the suggestive presence of gas collections within the abscess. Jeffrey et al. [12] found this sign in one of nine cases involving pyogenic abscesses of the psoas muscle. The demonstration of gas within the osteolytic focus itself appears to be much more

Fig. 3.—Case 3. Tuberculous osteomyelitis. **A**, Lateral tomographic section. Anterior wedge-shaped collapse of T7. Discrete osteolytic lesion of T8. Swelling of anterior prevertebral soft tissues. **B**, CT scan (T8–T7). Small gaseous collection within discovertebral osteolytic lesions (arrow). (Both pictures reprinted from [1].)

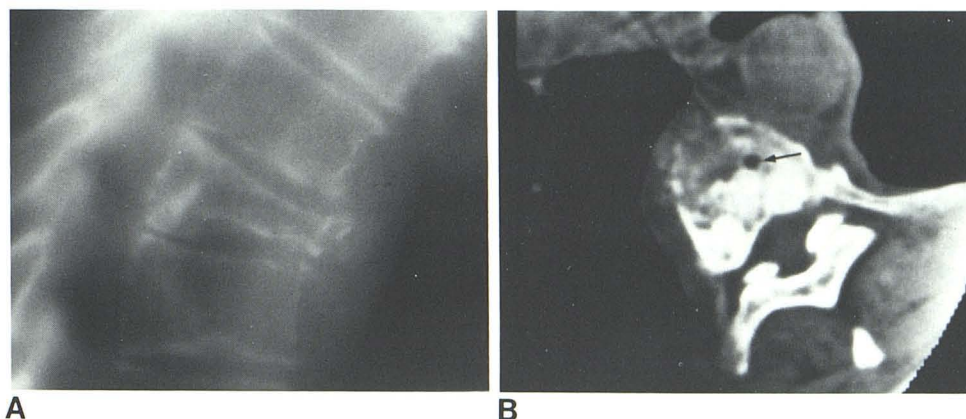


Fig. 4.—Spinal localization of Hodgkin disease. **A**, Lateral tomogram. Osteolytic lesion of inferior part of vertebral body of L3 with erosion opposite vertebral end plate. Significant narrowing of disk L3–L4. **B**, CT section centered on lower vertebral end plate of L3. Cortical disruption and spread of pathologic process to right psoas muscle. Disk density measured on lower section was normal ($d = 70$ H).

Fig. 5.—Large abscesses of both psoas with peripheral calcifications (tuberculous osteomyelitis). Discrete anterior epidural extension opposite discovertebral lesions.

exceptional [13]. Its discovery is consistent with the diagnosis of osteomyelitis, as in our case 3 (fig. 3).

In the follow-up of the spinal osteomyelitis, CT is most often requested when recurrence or complication of the infectious process is suspected months or years after the initial episode. In two cases, CT enabled us to prove the existence of suppurative collections located some distance from the primary focus. In one case, CT eliminated concern over an intraosseous punched-out lesion in the vertebral body by showing that it contained fat. Finally, in the more general context of secondarily narrowed spinal canals, CT offers the ideal imaging plane for investigation.

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