CLINICAL ARTICLE

Single Vertebra Tuberculosis Presenting with Solitary Localized Osteolytic Lesion in Young Adult Lumbar Spines

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Objective: To describe the clinical and imaging findings in young adults with single vertebra tuberculosis presenting with solitary osteolytic lesions.

Methods: Six patients with proven tuberculosis of a single vertebra of the lumbar spine presenting with solitary osteolytic lesion were retrospectively evaluated. There were four male and two female patients with a mean age of 27.6 years (range, 22–38 years). The clinical and imaging features (plain radiographs, CT and MRI) were studied in all six patients.

Results: Involvement occurred from L₁ to L₅ vertebral levels. The patients presented with local back pain and tenderness but without any obvious deformity of spine or cold abscess. In each case, imaging demonstrated a well-defined, solitary, lytic lesion of average diameter 1.6 cm with thin sclerotic margins within a vertebral body. There were no fragments within the lesions and no paravertebral soft tissue extension around the affected vertebral bodies. The tuberculous etiology was confirmed by CT-guided biopsy in two patients and by curettage of the lesion in four.

Conclusion: Tuberculosis affecting a single vertebral body presenting with a localized solitary osteolytic lesion is an unusual form of single vertebra tuberculosis. MRI combined with CT scan of the vertebral body can be very helpful for precisely defining the location of the lesion and extent of osseous destruction. Such small, solitary, osteolytic lesions are often confused with other single vertebra diseases that can have similar appearances on imaging.

Key words: Computerized tomography; Magnetic resonance imaging; Solitary osteolytic lesion; Spinal tuberculosis; Vertebral body

Introduction

Spinal tuberculosis in its classical form (i.e., two-vertebra disease with destruction of the intervening intervertebral disk and a paravertebral or psoas abscess) is easily recognized and readily treated in areas where tuberculosis is endemic^{1–4}. Atypical spinal tuberculosis without the aforementioned clinical or radiographic features⁵, although occurring less frequently⁶, has been well documented^{6–8}. However, only a few articles have reported isolated tuberculosis involving a single

vertebral body^{1,9,10}. Single vertebra tuberculosis presenting with a localized, solitary, osteolytic lesion without collapse of vertebral body is exceedingly rare and there is limited information about this entity in English-language published reports^{1,2,5–10}.

The purpose of this report was to describe six patients who had single vertebra tuberculosis presenting in the form of a localized, solitary, osteolytic lesion with normal architecture and arrangement of the vertebral bodies. We here

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present our findings concerning the radiological features of this rare, atypical pattern of spinal tuberculosis and discuss differential diagnosis of the single vertebra disease.

Materials and Methods

Patients with histologically-proven tuberculosis presenting as single vertebra tuberculosis in the form of a localized, solitary, osteolytic lesion who had been treated at our institution between 2003 and 2009 were identified from records and databases. The exclusion criteria were multiple sites of involvement, involvement of other elements of the vertebral column (e.g. appendages) and intervertebral disks, absence of a histological diagnosis and biopsy or other treatment at another hospital before being referred to our institution.

Four male and two female patients with a mean age of 27.6 years (range, 22–38 years) who fit these criteria were identified. Their initial clinical presentations were determined from their medical records, and the imaging features and pathology of each patient were reviewed.

Imaging studies consisted of plain radiography, CT and MRI for each patient. The CT studies were performed on a Philips whole body scanner (Philips, Shelton, CT, USA) with a slice thickness of 5 mm. The scans were obtained in high-resolution mode with magnification to show the vertebrae and surrounding soft tissues. The MRIs were performed with 1.5 T (Gyrosan system, Philips). Sagittal and axial T₁-weight and T₂-weight spin-echo images were acquired with repetition times of 541–618 msec and echo times of 15–17 msec (541–618/15–17), with 2–7 mm slice thickness and 256 × (128–256) matrix with a field of view of 24–28 cm.

The images were evaluated with regard to the presence and extent of vertebral involvement, appearance and extent of the lesions, destructive bone changes, paravertebral soft tissue mass extension and adjacent disk changes.

All patients had undergone routine laboratory tests. A raised erythrocyte sedimentation rate (ESR) was not thought to be significant for the diagnosis of tuberculosis, but was considered a useful measure of response to treatment.

Results

In this series of six patients all presented with solitary osteolytic lesions in a single lumbar vertebral body; one lesion was in L₁, one in L₂, two in L₃, one in L₄ and one in L₅.

All patients presented with local back pain and tenderness but without any obvious deformity of spine or cold abscess. Only one patient had symptoms of radicular pain. No patients had neurologic deficits on physical and neurological examinations or constitutional symptoms of tuberculosis, such as anorexia and weight loss. The ESR was increased in only two patients. Two patients had a past history of extraspinal tuberculosis (one pleural and one abdominal, Table 1).

Plain radiographs showed the lumbar vertebrae to be of normal shape and architecture. No patient had spinal deformity, bone destruction or height changes in intervertebral disks. In each patient, cross lumbar vertebral body CT scan

images showed a well-defined, solitary, localized, lytic lesion in the vertebral body surrounded by a thin sclerotic ring. The diameters of the osteolytic lesions ranged from 0.5 to 1.8 cm (mean, 1.5 cm). There were no fragments within the lesions and no paravertebral soft tissue extension around the affected vertebral bodies (Fig. 1a,b). The solitary osteolytic lesion was located in the central part of the vertebral body in three cases (Fig. 2a) and posterior part in three cases (Fig. 3a). None of the lesions were in the anterior part of the vertebral body.

The MRI images further characterized these well-defined, solitary localized masses in single lumbar vertebral bodies (Figs 1c, d, 2b, c, 3b). The affected vertebral bodies had hypointense signals on T₁-weighted images and hyperintense signals on T₂-weighted images throughout the affected vertebral bodies but without signal changes in the adjacent intervertebral disks. There was endplate disruption in three cases. No paravertebral soft tissue masses or spinal cord compression were found in this series of patients.

The tuberculous nature of the lesions was identified by CT-guided biopsy in two of the patients, pathological examination revealing epithelioid granulomas and Langerhan type giant cells, confirming the diagnosis of tuberculosis. In four patients, exploration and curettage of the lesions was performed and the final diagnosis of tuberculosis confirmed by histopathological examination of the operative specimens.

Antituberculous chemotherapy treatment (daily schedule rifampicin 600 mg; isoniazid 400 mg; ethambutol 1200 mg) was prescribed for 12 months postoperatively. The patients were followed up monthly for the first 6 months, 3 monthly for the following 12 months, and subsequently at yearly intervals. All six patients were followed up for at least 2 years (median, 4.7 years; range, 2–8 years). By the sixth month, all lower back pain had completely resolved. Satisfactory anterior or posterior fusion occurred in four patients. The median interval to solid fusion was 5 months (range, 3–7 months).

The patients gave their informed consent to publication of data about their cases.

Discussion

Published reports on single vertebra tuberculosis are so sparse that most such involvement is misdiagnosed^{1,9,10}. Because solitary osteolytic lesions are rarely caused by single vertebra tuberculosis, radiological studies and clinical findings may not be helpful in reaching the correct diagnosis^{11,12}.

Pathogenesis of Single Vertebral Body Tuberculosis

The origin of tuberculosis spondylitis is usually hematogenous rather than by direct extension from a contiguous paraspinal site. The typical initial site of infection is the anterior-inferior aspect of a vertebral body. The route of infection is controversial¹¹. The arterial route of transmission is recognized as more important¹³; however, some investigators favor the possibility that spread of tuberculosis occurs via Batson's valveless venous vertebral plexus^{14–17}. Tuli proposed that central single vertebral body lesions arise by infection reaching the vertebral body through Batson's venous plexus or branches of the posterior

TABLE 1 Clinical presentation and imaging features of six patients

No./sex/age (years)	Location	Symptoms	ESR (mm/1h)	Plain radiograph	CT scan	MR imaging	Treatment†
1/M/22	L ₂	Back pain and low-grade fever	37	Normal appearance	Single osteolytic lesion with surrounding slightly sclerotic ring in the posterior part of the vertebral body, 1.0 cm × 1.8 cm in diameter	A well-defined low intensity mass on T ₁ W, intermediate intensity mass on T ₂ W	Curettage of the lesion and autologous iliac bone graft
2/F/30	L ₃	Lower back pain, tenderness	13	No changes	A circumscribed osteolytic lesion in the posterior part of the vertebral body, 0.5 cm × 0.5 cm in diameter	Low signal intensity mass on T ₁ W, small low signal intensity mass on T ₂ W	CT-guided biopsy
3/M/23	L ₁	Lower back pain, tenderness	34	No changes	Single osteolytic lesion in the central part of the vertebra 0.7 cm × 0.6 cm in diameter	A low intensity mass on T ₁ W, low intensity mass on T ₂ W	CT-guided biopsy
4/F/25	L ₄	Tenderness in upper back	15	No changes	Single circumscribed osteolytic lesion in the posterior part of the vertebra 0.3 cm × 0.2 cm in diameter	A low intensity mass on T ₁ W, intermediate intensity mass on T ₂ W	Curettage of the lesion with posterior pedicle fixation
5/M/38	L ₅	Lower back pain	9	No changes	Single circumscribed osteolytic lesion in the central part of the vertebra 1.1 cm × 0.7 cm in diameter	A low intensity mass on T ₁ W, intermediate intensity mass on T ₂ W	Curettage of the lesion with autologous iliac bone graft
6/M/31	L ₃	Dull back pain radiating into the right leg	11	No changes	Single circumscribed osteolytic lesion in the posterior part of the vertebra 0.9 cm × 0.6 cm in diameter	A low intensity mass on T ₁ W, low-to- intermediate intensity mass on T ₂ W	Curettage of the lesion with autologous iliac bone graft

†, all patients received anti-tuberculous chemotherapy. F, female; M, male.

Fig. 1 Single vertebra tuberculosis presenting as a localized osteolytic lesion in a single lumbar vertebra. (A) Lateral plain lumbar spine radiograph showing normal shape and architecture of vertebral bodies without no visible bone destruction in vertebrae or appendages. The heights of the intervertebral disk spaces are normal. (B) Cross vertebral body CT scan showing a circumscribed localized solitary osteolytic lesion with well-defined margins in single vertebral body with no paravertebral soft tissue extension. (C) T₁ weight sagittal MRI demonstrating a globular intermediate signal intensity mass surrounded by low-intensity changes in the vertebral body of L₂. The shape of the vertebral body is normal with no compression or collapse. (D) T₂ weighted sagittal MRI showing a low to intermediate intensity mass surrounded by high-intensity circular margins and high-intensity changes in the rest of the vertebral body with normal signals for adjacent intervertebral disks.

Fig. 2 A 22-year-old man with a solitary osteolytic lesion in the central part of the L₃ vertebral body. (A) CT scan demonstrating a solitary intraosseous lytic lesion in the central part of the L₃ vertebral body with slightly sclerotic margins and no small bone fragments within the lesion. (B) T₁ weight sagittal MRI demonstrating a low signal intensity mass surrounded by intermediate signal intensity changes in the vertebral body of L₃. (C) T₂ weighted sagittal MRI showing a small low signal intensity mass surrounded by high-intensity signals in the posterior part of the L₄ vertebral body. The vertebra is normal in shape.

vertebral artery². Although involvement of a single vertebra by tuberculosis without involvement of the adjacent disk has been described^{5–10,12,18,19}, the mechanism by which the tubercle bacillus is deposited in a single vertebral body without involvement of adjacent vertebrae or the intervertebral disk is unclear. The initial stage of spinal tuberculosis seems to be the most likely explanation^{5,9}. Concentric collapse of the vertebral body or vertebra plana is the commonest form of single vertebra tuberculosis described in published reports^{1,5,10}; this form is easily confused with secondary deposits in the vertebral body⁹. In the cases of single vertebra tuberculosis described here, the presence of a solitary localized lytic lesion within an isolated vertebral body without involvement of the intervertebral disks and paraspinal soft tissue may be attributable to infection with less virulent than usual tubercle bacilli, early stage infection or strong immune responses. However, it is difficult to explain why, in our series, this unusual form of single vertebra tuberculosis occurred only in young adults, only involved the lumbar spine and did not affect the anterior part of the vertebral body, where tuberculous deposits are more common¹⁹.

Clinical and Radiographic Characteristics

All the patients in our study were in their third or fourth decade of life. Because their small solitary osteolytic lesions

started independently and were localized in a single lumbar vertebral body, the patients presented with local back pain and tenderness but without clinical manifestations of typical spinal tuberculosis, such as obvious deformity, palpable paraspinal abscess or constitutional symptoms of tuberculosis.

Plain radiography has limitations in finding this small solitary osteolytic lesions in the spine. Because the elements are superimposed on the vertebral body, plain radiographs usually cannot demonstrate foci of less than 1 cm in diameter well²⁰. Thus, plain radiographs may not accurately delineate small localized secluded lesions in a single vertebral body and the diagnosis may be missed.

Advanced imaging techniques such as CT or MRI are highly sensitive modalities for detecting secluded lesions in the spine and paravertebral soft tissue mass^{21,22}. CT is much more sensitive than radiographs for evaluating bone destruction, appendage involvement and soft tissue extension in spinal tuberculosis²⁰. Nevertheless, routine lumbar CT scans are usually performed to detect intervertebral disk pathology rather than pathology of the vertebral body, lumbar CT scans may fail to identify small solitary osteolytic lesions in an isolated vertebral body in a clinical setting, especially when there is a paucity of obvious clinical manifestations and plain films have not precisely located such a lesion. In fact, in three of our five cases MRI was the means of initial detection of the solitary

Fig. 3 A 25-year-old woman with pain and tenderness caused by a L₄ lesion. (A) Axial CT scan showing a small osteolytic lesion in the posterior part of the L₄ vertebral body. (B) The lesion has low signal intensity and is surrounded by high signal intensity margins in T₂ weighted MRI images. The rest of the L₄ vertebral body shows normal intensity signals.

osteolytic lesions. The other three were incidentally detected during CT imaging for suspected lumbar intervertebral disk herniation.

Because it is more sensitive, MRI is preferred to plain radiography, CT and nuclear medicine studies for detecting abnormalities of the bone marrow and soft tissues^{10,11,22}. Changes in both T₁ and T₂ weighted images are mainly caused by increased water content in inflamed vertebrae and associated ischemic changes in the bone marrow, resulting in early detection of pathological processes^{9,23}. MRI also has the capacity of multiplanar imaging and visualization of secluded lesions in all elements of the spine^{12,13}. MRI is useful for evaluation of spinal tuberculosis because the signal intensity of the affected vertebral marrow decreases on T₁ weighted images and increases on T₂ weighted images because edematous inflammatory involvement replaces the normal fat content¹². The solitary localized lesions in our series of cases usually had a low-to-intermediate signal intensity on T₁ weighted and a low-to-intermediate signal intensity mass surrounded by high signal intensity margins on T₂ weighted magnetic resonance images. The uninvolved part of the affected vertebral bodies showed high-intensity changes on T₂ weighted imaging.

The imaging findings of single vertebra tuberculosis presenting with a solitary localized osteolytic lesion has not been reported previously^{1,2,6-9}. The typical image in our series of six cases was a small (approximately 0.5–1.8 cm diameter) solitary

“lytic” zone in an isolated lumbar vertebral body, with clear margins from the encompassing minimal osteosclerotic reaction peripherally and rarely extending into adjacent soft tissues. This presentation may represent localized bone erosion from tuberculosis or tuberculous spondylitis in its initial stages. In adults with a solitary osteolytic lesion in a single vertebral body, tuberculosis should be considered. CT combined with MRI is of great value both diagnostically and to assist decisions about therapy in these rare cases of spinal tuberculosis.

Differential Diagnosis

Single vertebra tuberculosis presenting with a solitary localized osteolytic lesion is easily confused with other single vertebra diseases that may have a similar imaging appearance, such as focal infection²³, a secondary deposit in a single vertebral body¹⁸, solitary bone cysts^{24,25}, osteoid osteomas²⁶, osteoblastomas²⁷ and eosinophilic granulomas²⁸.

Based on imaging findings alone, differentiating a localized spinal tuberculosis lesion from focal pyogenic spondylitis is usually difficult where there is isolated bone destruction^{9,12,29}. Collapse of the vertebral body is rare in pyogenic spinal infection but common in spinal tuberculosis²³. In the chronic stage, tubercular spondylitis has slightly hyperintense signals of the vertebral body on T₁ weighted images, whereas non-tuberculous spondylitis has low signal intensity²³. On CT,

well-defined margins around a localized lytic lesion favor a diagnosis of tuberculosis over other types of focal spinal infection.

A solitary bone cyst involving the spine is extremely rare, only a few cases of histologically proven solitary bone cysts affecting a vertebral body having been reported²⁴. The typical imaging finding of a large osteolytic lesion surrounded by obvious bone sclerosis²⁵ may help to differentiate it from other pathologies.

Osteoid osteoma, a benign lesion, is typically approximately 1 to 2 cm in diameter and has clear margins between it and the surrounding reactive bone. 10%–20% of all osteoid osteomas occur in the spine. Posterior elements such as the perpendicular region of the arch, pedicle, lamina, or transverse process are most commonly affected; less than 10% of spinal osteoid osteomas affect the vertebral body. The nidus of the tumor may not be visible on routine studies but a CT scan can usually detect central nidus calcification²⁶.

Osteoblastoma, another benign tumor of bone; is histologically identical to osteoid osteoma but typically several centimeters larger²⁷. This expanding osteolytic lesion may affect not only the lamina and transverse processes but also the adjacent rib. Spinal osteoblastomas are typically expansile with a scalloped or lobulated contour, well-defined margins and sometimes a sclerotic rim.

In children, eosinophilic granuloma mainly involves the vertebral bodies and can present with solitary vertebral body involvement. Posterior element involvement is less common. Involvement of the vertebral body may result in anterior wedging or near collapse with a characteristic “vertebra plana” appearance. However, eosinophilic granuloma in the adult lumbar spine is very rare, only a few reports having been published in the English language²⁸. MRI reveals an isointense mass surrounded by low-intensity changes on T₁ weighted images and a high-intensity mass surrounded by high-intensity changes on T₂ weighted images.

Conclusions

A localized solitary osteolytic lesion in a single vertebral body is a rare form of spinal tuberculosis. Diagnosis is often delayed because such lesions are not usually evident on plain radiographs and conventional lumbar intervertebral disk CT scan. When a vertebral column lesion is suspected, CT scanning of the cross-vertebral body followed by MRI is very helpful for precisely defining the location of a secluded lesion and the extent of osseous involvement. Evaluating a solitary localized osteolytic lesion in a single vertebra can be a perplexing task; however, a definite diagnosis may be achieved by CT-guided biopsy or surgical intervention.

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