CME Article

Imaging of tuberculosis of the spine

E L H J Teo, W C G Peh

ABSTRACT

Tuberculosis (TB) is the leading cause of death worldwide that can be attributed to a single infectious agent. With the onset of the AIDS epidemic, there has been a resurgence of TB in recent years. Skeletal TB constitutes 1% to 3% of extrapulmonary cases, and typically involves the spine. TB of the spine should be considered in the differential diagnosis of many spinal conditions affecting patients of all ages. The pathophysiology, clinical and imaging features of TB of the spine are reviewed, with illustrations of findings on radiography, computed tomography and magnetic resonance imaging. Familiarity with the imaging features of TB of the spine may enable a more rapid diagnosis to be made, thereby preventing a delay in diagnosis with its consequent complications.

Keywords: computed tomography, infective spondylitis, magnetic resonance imaging, radiography, tuberculosis

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INTRODUCTION

Tuberculosis (TB) is the leading cause of death worldwide that can be attributed to a single infectious agent[1]. The incidence of TB in Singapore is 44 per 100,000 people and is high compared to developed countries[2]. In the United States, Australia and Sweden, the incidence is less than 10 per 100,000 while in Japan, the incidence is 33 per 100,000. More than 40% of TB cases worldwide occur in South-East Asia[3]. In this region, there is an estimated 3 million new cases of TB every year, making this the world's hardest hit region[4]. With the onset of the acquired immunodeficiency syndrome (AIDS) epidemic, there has been a resurgence of TB[5]. Worldwide, there is an estimated 10.7 million people with both human immunodeficiency virus (HIV) and TB infections. It is estimated that almost one million people in Asia and the Pacific acquired HIV in 2002, bringing to an estimated 7.2 million the number of people now living with HIV in the region[6].

Extrapulmonary TB constitutes only 10% to 15% of all TB cases. However, in HIV patients, a higher frequency of extrapulmonary TB is seen[7]. Skeletal TB constitutes 1% to 3% of extrapulmonary cases[5], and typically involves the spine. The extra-axial joints and bones are less commonly involved. TB spondylitis or Pott's disease was first described by Percival Pott in 1779. However, TB spondylitis has been detected in ancient mummies in Egypt and Peru, and is hence one of the oldest diseases known to mankind. With the advent of anti-tuberculosis treatment, the incidence of TB spondylitis has fallen in industrialised countries but may rise again because of the AIDS epidemic. The objective of this pictorial essay is to review the radiological appearances of TB of the spine.

PATHOPHYSIOLOGY

In musculoskeletal TB, active lung infection is present in less than 50% of cases[5]. The spine is involved in up to 50% of cases of musculoskeletal TB. The thoracolumbar junction is the most commonly involved site but many levels may be involved at presentation[8]. TB usually spreads to the vertebral body via the blood stream. In most cases, the infection commences in the anterior subchondral region of the vertebral body adjacent to the intervertebral disc[5] (Fig. 1). The posterior elements are seldom involved. Spread to the intervertebral disc occurs by direct extension. Subligamentous spread of the disease (Fig. 2) to other levels and extension of infection into the surrounding soft tissues to form paravertebral abscesses occur frequently (Fig. 1c). These abscesses may track and discharge in unusual locations, such as the groin, buttock or chest[5].

Disease involvement into the iliopsoas muscle is a classical mode of extension. Collapse of multiple levels of vertebral body due to osseous destruction results in a gibbus deformity (Fig. 3). Neurological complications may occur in severe cases due to spinal cord compression and meningitis. Less common patterns of infection include involvement

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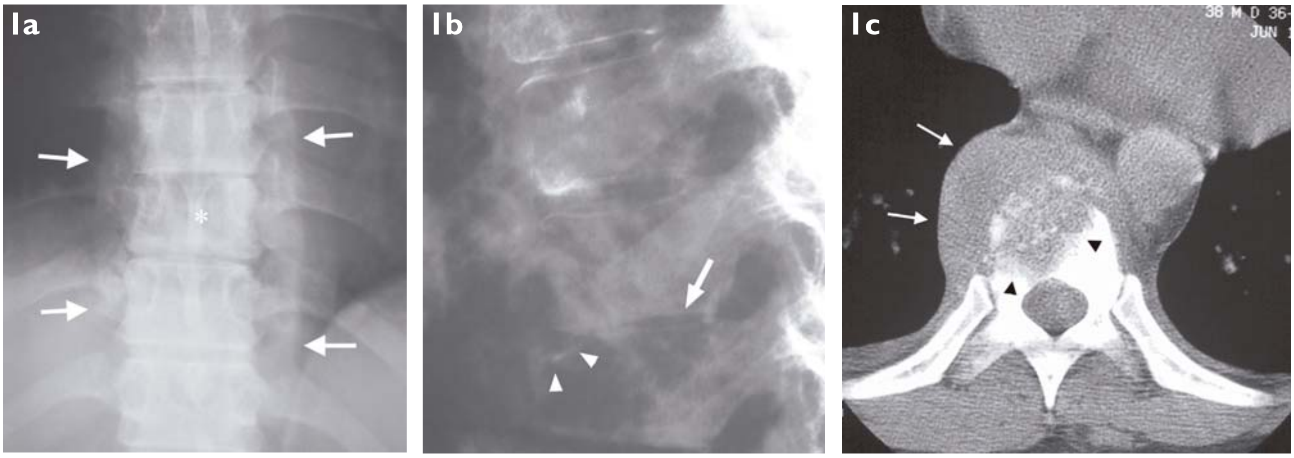


Fig. 1. TB spondylodiscitis in a 38-year-old man. **a)** AP radiograph of the thoracolumbar spine shows partial loss of height of T9 vertebral body (*). Loss of T8/9 disc and end-plate irregularity are seen. Paravertebral masses (arrows) are noted. **b)** Lateral radiograph shows anterior wedging and erosion of antero-superior subchondral region of T9 vertebral body (arrowheads). Narrowing of the T8/9 intervertebral disc space is present (arrow). **c)** Axial CT image of T9 vertebral body shows vertebral body destruction (arrowheads), with associated adjacent soft tissue mass (arrows).

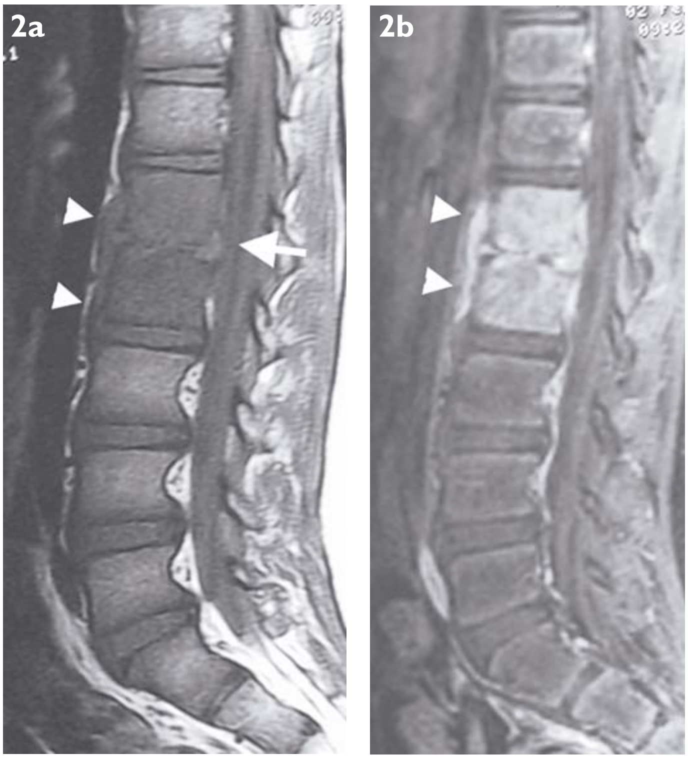


Fig. 2 Subligamentous spread of TB in a 10-year-old boy. **a)** Sagittal T1-W MR image shows narrowing of L1/2 intervertebral disc space (arrow). The L1 and L2 vertebral bodies are hypointense due to bone marrow inflammation and oedema. Subligamentous soft tissue spread is seen (arrowheads). **b)** Enhanced fat-suppressed sagittal T1-W MR image shows enhancement of the L1 and L2 vertebral bodies, L1/2 disc and subligamentous inflammatory tissue (arrowheads).

of the posterior elements (Fig. 4), sparing of the intervertebral disc, involvement of non-contiguous vertebral bodies and marked reactive sclerosis[8]. Increased morbidity is noted in these cases.

CLINICAL FEATURES

Patients with TB of the spine present with a gradual onset of back pain, stiffness, local tenderness and sometimes, fever. Cord compression and paralysis may result from granulation tissue, bone destruction and collapse, or extension into the spinal canal. Neurological abnormalities may occur in up to 50% of cases. Other than paraplegia and paresis, impaired sensation, nerve root pain, or cauda equina syndrome may also occur. Cervical spine disease is uncommon but is potentially more dangerous because severe neurological complications can occur. Neck pain, stiffness, hoarseness of voice, dysphagia and torticollis may be presenting symptoms. Extension of the disease into the psoas muscle may produce a groin mass, hip movement limitation and referred pain. Occasionally, this may be the mode of presentation (Fig. 5).

IMAGING FEATURES

Radiographical findings generally occur late. It is estimated that over 50% of trabecular bone must be destroyed before it becomes evident on radiographs[9]. Radiographical features of TB include narrowing of the intervertebral disc space, adjacent end-plate irregularity and erosion, sequestrae and paravertebral masses (Figs. 1a-b, 6a & 7). When disease extension into the psoas muscle occurs, the psoas outline may be asymmetrical with outward bulging. Scalloping of the anterior vertebral body may be present due to spread beneath the anterior longitudinal ligament[5] (Fig. 1b). It is difficult to distinguish TB spondylitis from pyogenic spondylitis radiologically, and correlation with the details of

Fig. 3 Gibbus deformity in previously-operated thoracolumbar spine. Lateral radiograph shows bony ankylosis in a severely kyphotic position.

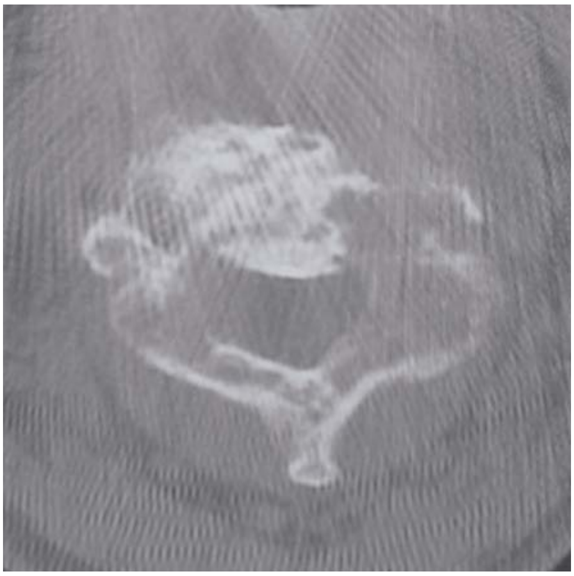


Fig. 4 Posterior element involvement in TB of the cervical spine. Axial CT image of C2 vertebra shows marked reactive sclerosis and destruction of both anterior and posterior elements.

clinical and social history is necessary to provide the clues for diagnosis.

Atypical presentations of TB include isolated involvement of the central portion of a vertebral body without adjacent disc involvement. Vertebral collapse, similar to a vertebra plana, may occur[5]. Magnetic resonance (MR) imaging shows a signal abnormality of the vertebral body without disc involvement. This appearance is indistinguishable from that of lymphoma or metastasis. Isolated involvement of the posterior elements is another atypical appearance. In elderly patients, TB may appear similar to bony

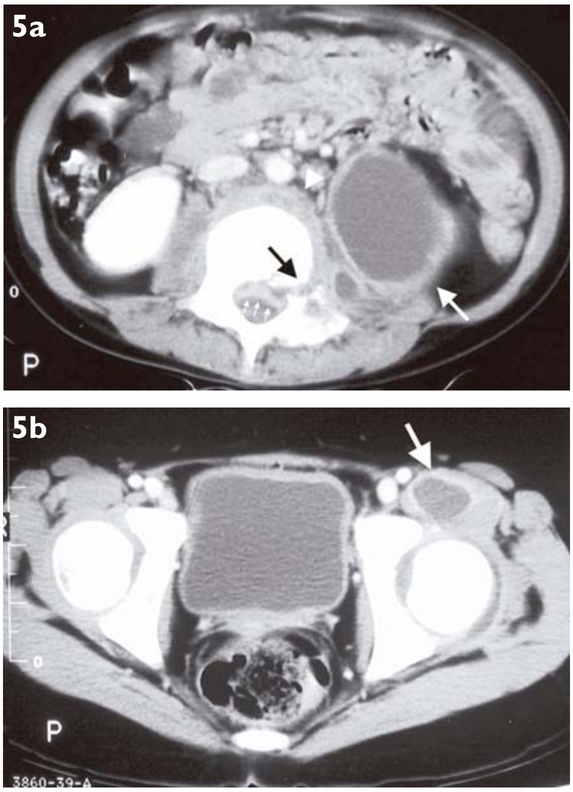


Fig. 5 Spread of TB spondylitis through the left psoas muscle to the left groin in a 14-year-old boy. **a)** Enhanced axial CT image taken through L3 vertebral body shows bony destruction in the left pedicle (black arrow), large left psoas abscess (large white arrow), subligamentous spread (arrowhead) and extradural spinal canal invasion are seen (small white arrows). **b)** Axial CT image shows the psoas abscess tracking down into the left inguinal region (arrow).

metastases. In the HIV-positive patient, multifocal bone lesions may also occur.

Computed tomography (CT) is able to clearly demonstrate bony sclerosis and destruction within the vertebral bodies (Figs. 1c, 4, 5a, 6b & 7b). CT complements radiographs and is indicated if initial radiographs are positive or suspicious. Epidural abscesses, bony fragmentation and spinal canal compression are also well seen (Figs. 5a, 6b & 7). CT myelography can accurately assess spinal cord compression if MR imaging is not readily available (Fig. 8). Reformatted two- dimensional (2D) images with spiral or multislice CT scanning offers a multiplanar perspective to CT scanning techniques without the need to re-scan the patient in a different plane. Viewing images of the same anatomical region in a different plane may help to clarify areas of ambiguity that may be present if viewed only in a single plane. CT can also be used to guide percutaneous biopsy of infected bone or soft tissue structures (Fig. 9).

MR imaging is able to detect changes within the vertebra and end-plate irregularity earlier than radiographs and bone scintiscans[8]. The high

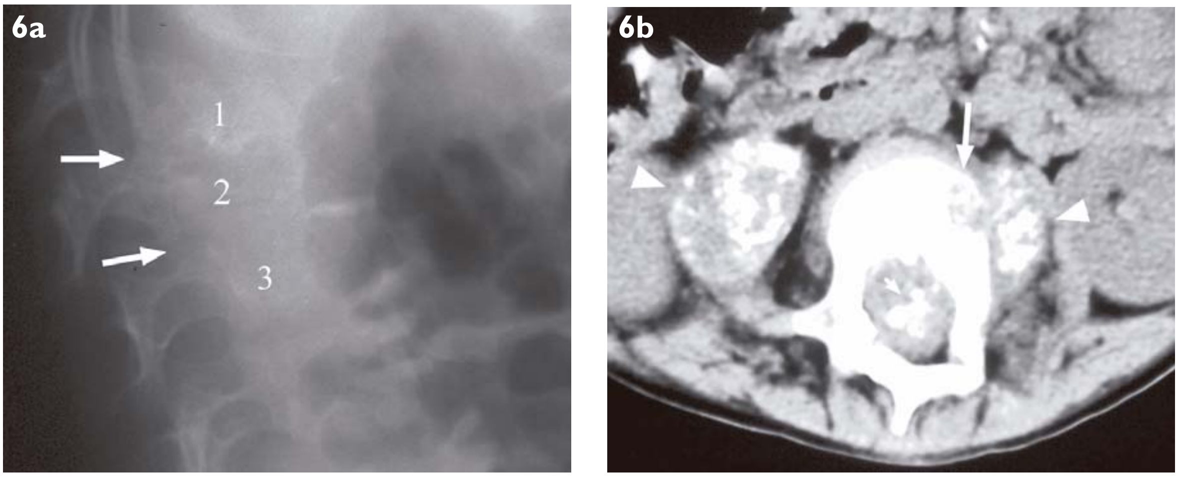


Fig. 6 Collapsed vertebral body in 10-year-old child with L1-3 TB spondylitis. **a)** Lateral radiograph of the lumbar spine shows collapse of L1, L2 and L3 vertebral bodies. The L1/2 and L2/3 intervertebral disc spaces are also narrowed and poorly-delineated (arrows). **b)** Axial CT image taken through the L2 vertebral body shows a large erosion in the left side of the vertebral body (arrow). Calcifications are noted in both psoas muscles (arrowheads). Calcified soft tissue is also seen within the spinal canal, causing compression (small arrow).

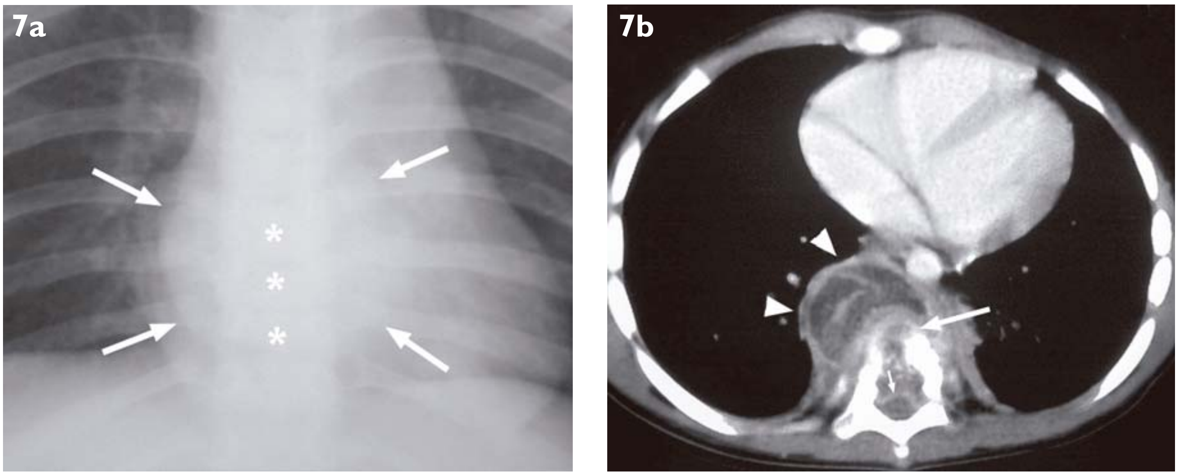


Fig. 7 2-year-old child with TB spondylitis. **a)** AP chest radiograph shows a large paraspinal mass (arrows) adjacent to collapsed T7-T9 (*) vertebral bodies. **b)** Axial CT image taken through T8 vertebral body shows vertebral body destruction (arrow). A paravertebral abscess (arrowheads) with extension into the spinal canal (small arrow) is noted.

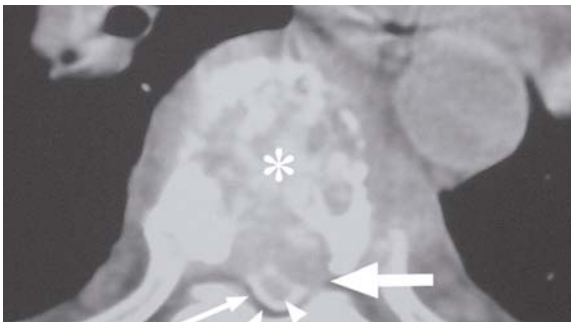


Fig. 8 63-year-old man with pulmonary TB who presented with bilateral lower limb weakness. CT myelogram shows contrast material (small arrows) surrounding the compressed spinal cord (arrowhead). Compression is caused by the soft tissue component (large arrows) from the destroyed T9 vertebral body (*) due to TB.

Fig. 9 CT-guided needle biopsy. Axial CT image taken through L2 vertebral body shows the biopsy needle within the diseased vertebral body.

contrast and superior soft tissue resolution, and multiplanar capabilities of MR imaging make it the modality of choice for evaluating soft tissue extension. Early in the disease process, MR imaging is very sensitive in the detection of marrow changes. Intervertebral disc involvement is also well seen on MR imaging (Fig. 10). Vertebral osteomyelitis is hypointense on T1-weighted images and hyperintense on T2-weighted images[10] (Figs 2 & 10). In established TB, signal changes become more heterogeneous. Epidural and soft tissue abscesses, as well as bone marrow involvement, enhance inhomogeneously after the administration of intravenous MR contrast, Gd-DTPA[5] (Figs. 2 & 11). Imaging also has a useful role in follow-up of spinal TB that has been treated (Fig. 12).

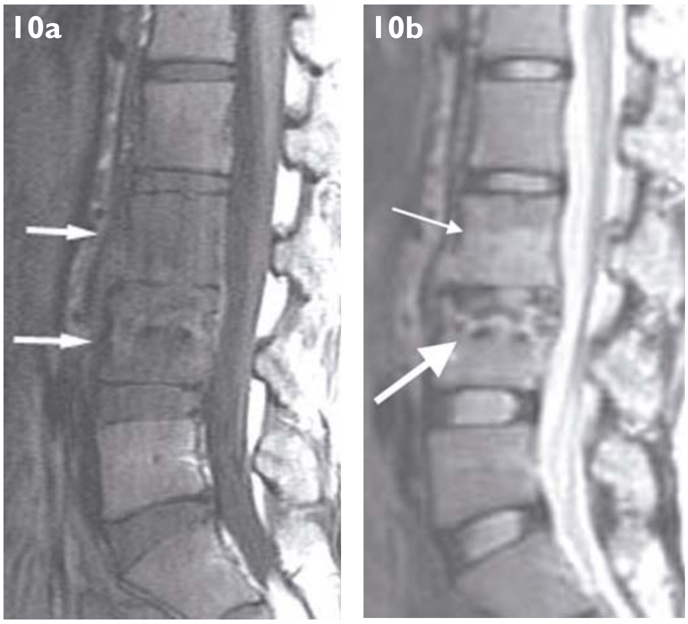
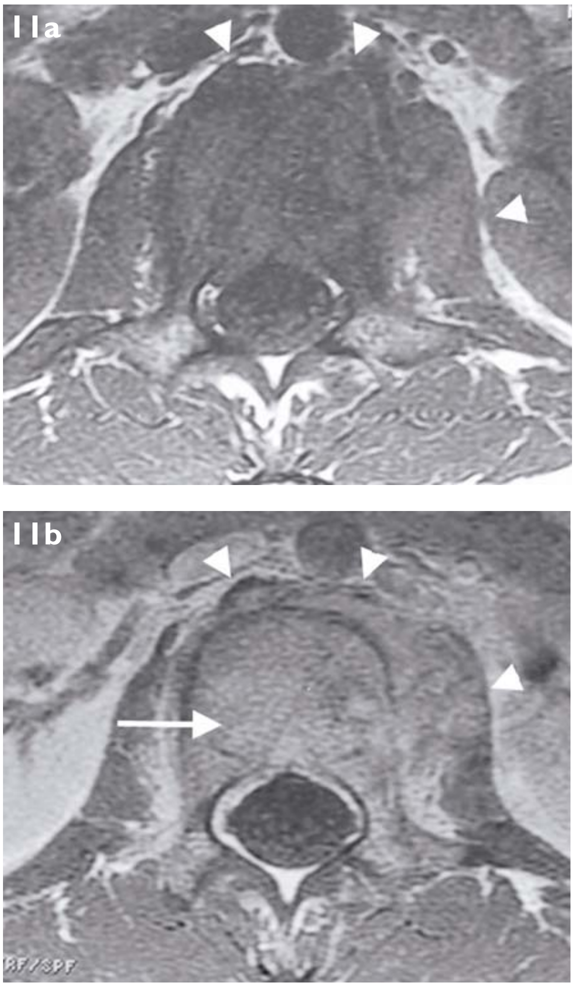


Fig. 10 MR imaging of early TB spondylodiscitis. **a)** Sagittal T1-W image shows the L3 and L4 vertebral bodies to be low in signal intensity (arrows) due to diffuse marrow involvement. **b)** Sagittal T2-W image shows irregularity of the superior end-plate of the L4 vertebral body (large arrow). The L3/4 intervertebral disc is also low in signal intensity compared to the other intervertebral discs. Increased signal intensity is also noted in the L3 vertebral body. *(Case courtesy of Assoc. Prof. Suphaneewan Jaovisidha, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand.)*

DIFFERENTIAL DIAGNOSIS

TB of the spine should be considered in the differential diagnosis of any patient presenting with back pain. It is important to be able to diagnose TB as it can be successfully treated, especially if detected early. There are no characteristic features of TB spine, and radiological differential diagnosis includes pyogenic



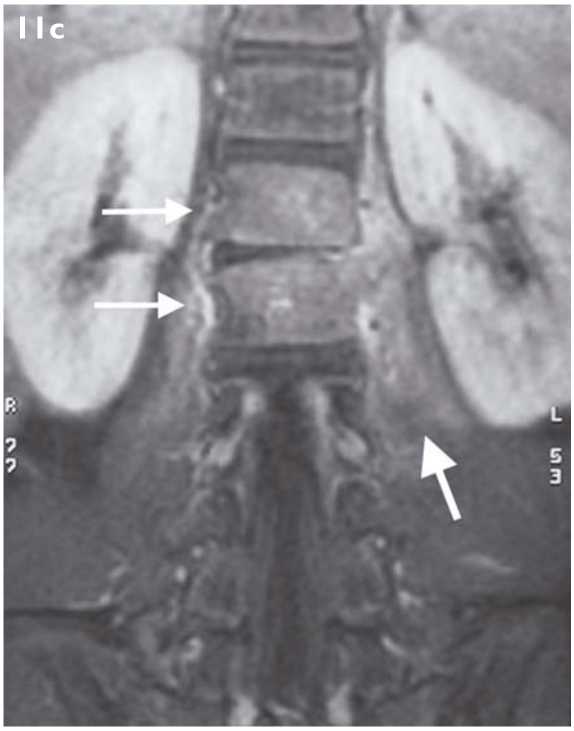


Fig. 11 MR imaging of TB spondylitis with subligamentous and left psoas involvement. **a)** Axial T1-W MR image taken through L1 vertebral body shows inflammatory tissue in the subligamentous region and to the left of vertebral body (arrowheads). **b)** Enhanced fat-suppressed axial T1-W MR image taken through L1 vertebral body shows marked enhancement of the inflammatory tissue in the subligamentous region and in the left psoas muscle (arrowheads). Enhancement within the vertebral body is also noted (arrow). **c)** Enhanced fat-suppressed coronal T1-W image shows enhancement of the L1 and L2 vertebral bodies (small arrows). Enhancement of the left psoas muscle is also noted (large arrow).

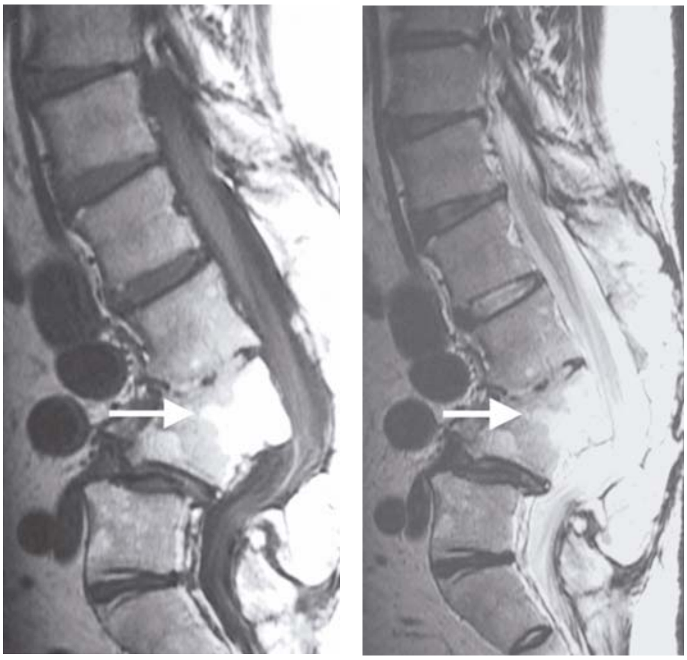


Fig. 12 Follow-up MR imaging of an elderly man with previous TB spondylitis and now presenting with back pain. Sagittal **(a)** T1- and **(b)** T2-W images show bony ankylosis of the L3/4 vertebral bodies resulting in kyphosis. Fatty marrow infiltation is noted within the vertebral bodies (arrows). The adjacent spinal canal is deformed and narrowed.

and fungal infections. Although differentiation between pyogenic and TB infection is often difficult in individual cases, some general guidelines may be helpful. Patients with pyogenic spondylitis may, in some cases, be more toxic compared to TB. TB of the spine is usually more chronic and is slower in progression, compared to pyogenic spondylitis. This is reflected radiographically as increased areas of sclerosis[11]. The soft tissue abscesses and paravertebral extension in TB are usually larger, compared to pyogenic spondylitis. Soft tissue calcifications are more characteristic of TB than pyogenic spondylitis[12]. TB more commonly involves more than one vertebral level.

In metastatic disease, lymphoma and multiple myeloma, subligamentous spread and disc involvement is not typically seen. The disc height is usually preserved in such cases but may rarely be involved in lymphoma and multiple myeloma. The vertebral end-plates are also distinct and usually regular[5]. Adjacent surrounding inflammatory collections are usually not present in tumour infiltration. In all cases, obtaining tissue for culture and sensitivity is essential in arriving at a definitive diagnosis, and spinal biopsy is best done under CT guidance.

MANAGEMENT

The mainstay of treatment is TB chemotherapy of 12 months duration. Initial treatment of uncomplicated spinal TB is conservative. Surgical treatment may be required if an abscess or neurological complication is present or impending.

CONCLUSION

TB of the spine should be considered in the differential diagnosis of many spinal conditions affecting patients of all ages. Familiarity with the imaging features of TB of the spine may enable a more rapid diagnosis to be made, thereby preventing a delay in diagnosis with its consequent complications.

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SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME

Multiple Choice Questions (Code SMJ 200409B)

	True	False
Question 1. The following statements are true:		
(a) The incidence of TB in Singapore is 44 per 100,000 people.	❑	❑
(b) More than 40% of TB cases worldwide occur in South-East Asia.	❑	❑
(c) Extrapulmonary TB constitutes only 10% to 15% of all TB cases.	❑	❑
(d) Skeletal TB constitutes 20% of extrapulmonary cases.	❑	❑
Question 2. In musculoskeletal TB:		
(a) Active lung infection is present in less than 50% of cases.	❑	❑
(b) The spine is involved in more than 50% of cases.	❑	❑
(c) The thoracolumbar junction is the most commonly involved site in TB of the spine.	❑	❑
(d) Infection usually occurs through haematogeneous spread of the organism.	❑	❑
Question 3. In TB of the spine:		
(a) The posterior elements are seldom involved.	❑	❑
(b) Spread to the intervertebral disc occurs by direct extension.	❑	❑
(c) Subligamentous spread of the disease to other levels occurs frequently	❑	❑
(d) Disease involvement into the iliopsoas muscle is a classical mode of extension.	❑	❑
Question 4. Regarding imaging features of TB of the spine:		
(a) Radiographical findings occur early.	❑	❑
(b) Radiographical features of TB include narrowing of the intervertebral disc space.	❑	❑
(c) The psoas outline may be asymmetrical with outward bulging.	❑	❑
(d) It is difficult to distinguish TB spondylitis from pyogenic spondylitis radiologically.	❑	❑
Question 5. In TB of the spine, MR imaging:		
(a) Is able to detect changes within the vertebra and end-plate irregularity earlier than radiographs and bone scintiscans.	❑	❑
(b) Is the modality of choice for evaluating soft tissue extension.	❑	❑
(c) Is useful in the follow-up of the disease process during treatment.	❑	❑
(d) Epidural and soft tissue abscesses, as well as bone marrow involvement, enhance inhomogeneously after the administration of intravenous MR contrast, Gd-DTPA.	❑	❑

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