Imaging spectrum of musculoskeletal tuberculosis: Pictorial essay

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Learning objectives

- To describe the characteristic radiological signs of tuberculosis involving the musculoskeletal system.
- To illustrate cases depicting tuberculous affliction of spine, bones and joints.
- To depict the complications and sequelae of tuberculosis.
- To discuss the mimickers of tuberculosis.

Background

Tuberculosis (TB) has always been a major public health problem in developing countries. The incidence had decreased with the introduction of antituberculous drugs but resurgence has been seen due to drug resistance. Prevalence has increased in developed countries due to large population suffering from chronic diseases (e.g., diabetes mellitus, chronic renal failure, chronic obstructive disease, liver cirrhosis, lymphoproliferative disorders, etc.), a growing number of immunocompromised patients; the emergence of multidrug-resistant TB; and various socioeconomic factors (e.g., alcohol and drug abuse, poverty, homelessness, etc.). High prevalence is seen among patients with AIDS who often present with it as first manifestation of HIV infection.\(^1\)

In 20% of patients with TB extrapulmonary manifestations occur. Musculoskeletal TB accounts for 1-3% of tuberculous infections. The most common form being tuberculous spondylitis (50%). Extraspinal manifestations are uncommon. Frequency of peripheral arthritis is around 60%, of osteomyelitis 38%, and of tenosynovitis and bursitis 2%. Coexistent active pulmonary TB is seen only in 50% of the patients.\(^2\)

Patients with musculoskeletal TB present with nonspecific, subtle symptoms due to which diagnosis may be delayed. However, if prompt diagnosis is made an early treatment can prevent joint deformity and permanent bone destruction. Clinical and imaging findings alone cannot diagnose musculoskeletal TB but correlation with rest of diagnostic workup can help in an earlier diagnosis and prompt institution of treatment.

It is essential to identify the common and uncommon radiologic findings so that an accurate and early diagnosis can be made to prevent complications.

ETIOPATHOGENESIS:

Main causative organism is Mycobacterium tuberculosis, only a few cases are caused by Mycobacterium bovis. 1-4% of cases are caused by atypical mycobacteria like
Mycobacterium kansasii, Mycobacterium marinum, Mycobacterium scrofulaceum, and Mycobacterium avium complex.

Dissemination of mycobacteria to musculoskeleton occurs mostly by haematogenous route. Direct inoculation of the organism into the site occurs rarely.

**TUBERCULOUS SPONDYLITIS:**

Also known as Pott disease.

Thoracolumbar junction is most frequently involved. Usually infection spreads hematogenously by perivertebral arterial plexus or venous plexus of Batson, or rarely by contiguous spread from a paraspinal infection.

Clinical manifestations include persistent spinal pain, tenderness, limitation of mobility and constitutional symptoms\(^3\).

The superior or inferior anterior vertebral body corner in the paradiscal location are involved first. Further spread of infection can occur by subligamentous route or through the subchondral plate. Disc involvement occurs late with narrowing due to herniation of the disc into the collapsed vertebral body. Gibbus deformity can occur due to collapse of multiple vertebrae with anterior wedging.

**TYPES OF TUBERCULOUS INVOLVEMENT OF THE SPINE:**

**Paradiscal or the marginal type:** It is the most common type. Infection starts at the end plates with subsequent involvement of the vertebral body.

**Anterior subperiosteal:** Infection starts beneath the periosteum at the anterior vertebral margin and spreads underneath the anterior longitudinal ligament.

**Central:** It is seen as a lytic area in the center of the vertebral body. Initially expansion occurs followed by a concentric collapse resembling vertebra plana.

**Appendiceal or neural arch tuberculosis (NAT):** There is involvement of posterior elements. Its a rare type of tubercular spine (<2%).

**TUBERCULOUS ARTHRITIS:**
Infection can spread to the joints by contiguous spread (from adjacent metaphyseal lesion) or hematogenously.

Monoarticular joint involvement is more common, multifocal disease is seen in approximately 10% of patients\textsuperscript{4}.

Due to the Synovial hypertrophy pressure necrosis occurs causing peripheral and central erosions. Subchondral bone and articular cartilage destruction occurs however joint space narrowing is a late complication. Paraarticular soft tissue masses, cold abscesses and sinus tracts may also develop. Demineralization and local bone destruction can occur due to reactive hyperemia.

**TUBERCULOUS OSTEOMYELITIS:**

Monoostotic involvement with the bones of extremities including small bones of hands and feet more commonly involved. Infection spreads from an active focus by haematogenous route\textsuperscript{5}.

In tubercular dactylitis short tubular bones of the hands and feet are more commonly involved. Presentation is subtle without fever and acute inflammatory signs unlike acute osteomyelitis. The involved bone has a ballooned out appearance with an internal cyst like cavity. Soft tissue swelling with periosteal thickening and bone destruction occurs. Presentation is subtle without fever and acute inflammatory signs unlike acute osteomyelitis.

Multifocal tuberculous osteomyelitis (osteitis cystica tuberculosa multiplex), is a rare pattern of TB osteomyelitis which is more common in children. Commonly the metaphyses of long bones are affected.

**TUBERCULOUS TENOSYNOVITIS AND BURSITIS:**

This may result from hematogenous spread or there maybe periarticular extension of tuberculous arthritis. Thickening and infiltration of tendon or synovium can occur, in the later stage of the disease thinning of the tendon and tendon rupture may occur\textsuperscript{1}. Secondary involvement of synovium of bursae is more common than primary bursitis.

**TUBERCULOUS MYOSITIS:**

Muscle and deep fascia is rarely seen in musculoskeletal TB. It is mostly seen in immunosuppressed patients. Chest wall involvement occurs more commonly in parasternal region, costovertebral junction, and along the shafts of the ribs.
Fig. 1: AP and lateral radiographs of dorso lumbar spine of a child showing partial collapse of T12,L1,L2 vertebral bodies with kyphotic deformity.
**Fig. 2:** Saggital T1 and T2W images showing collapse of T12 and L1 vertebrae with prebvertebral (white arrow) and epidural collection (black arrow) with cord compression.
Fig. 3: Gadolinium enhanced T1W sagittal image of dorso-lumbar spine showing collapse of T12-L1 vertebrae with subligamentous spread of peripherally enhancing prevertebral collection (arrow) with cord compression.
Fig. 4: Coronal T2W image dorso lumbar spine showing prevertebral and bilateral paravertebral collection (arrow) opposite T12, L1 vertebrae.

Fig. 5: AP radiograph of lumbar spine showing lytic lesion involving left pedicle and transverse process of L4 vertebra. Corresponding axial CT image shows abscess in left psoas muscle.
Fig. 6: AP radiograph of lumbar spine showing calcified right psoas abscess(arrow).
Fig. 7: Flattening of bilateral femoral heads left> right, with irregularity and subchondral sclerosis(left) in acetabulum and femoral head with reduced joint space
**Fig. 8:** Tuberculous arthritis knee joint. AP radiograph of knee joint showing peripheral erosions and reduced joint space with minimal subchondral sclerosis.

Fig. 9: AP and lateral hand radiographs showing cystic, expansile lysis (spina ventosa) with cortical thinning of the proximal phalynx of third digit.
Fig. 10: Lateral radiograph of the elbow showing multiple, well-defined lytic lesions of variable size in the metaphyses of the humerus, radius and ulna (arrows) with soft tissue swelling.
**Fig. 11:** Chest PA radiograph showing irregular lytic destruction of multiple ribs bilaterally (arrows) in a case of Tuberculous osteomyelitis of ribs.
**Fig. 12:** AP and lateral radiographs of knee joint showing soft tissue swelling and fullness in supra-patellar bursa (arrow).
**Fig. 13:** Axial post contrast fat suppressed T2W image showing peripherally enhancing abscess in greater trochanter of left femur (blue arrow) with hyperintensity (white arrow) in adjoining muscle suggestive of myositis.
Fig. 14: Sagittal T1W and fat suppressed T2W image of ankle joint showing periarticular effusions (arrow) with bone erosion of the talus.
Fig. 15: Post tubercular sequelae showing ankylosis of elbow joint.
<table>
<thead>
<tr>
<th>Imaging findings OR Procedure details</th>
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<tbody>
<tr>
<td><strong>TUBERCULAR SPONDYLITIS</strong> (fig 1-6)</td>
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<tr>
<td><strong>PLAIN RADIOGRAPH</strong></td>
</tr>
<tr>
<td>• indistinct paravertebral end abscess plates</td>
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<tr>
<td>• loss of vertebral height</td>
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<tr>
<td>• narrowing of disc space and collapse of vertebra with kyphotic deformity</td>
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<td>• lytic destruction (no reactive sclerosis or periosteal reaction)</td>
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<tr>
<td>• Anterior erosions d/t subligamentous involvement</td>
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<td>• Fusiform abscess (<em>bird's nest appearance</em>) in thoracic spine,</td>
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<td>• Converging lower border of</td>
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<td><strong>USG</strong></td>
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<td>• end plate postcontrast destruction</td>
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<tr>
<td>• fragmentation of the vertebrae</td>
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<tr>
<td>• pre- and paravertebral abscesses</td>
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<tr>
<td>• Calcification of the collections</td>
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<tr>
<td>• extension of bony fragments and epidural abscess into the spinal canal</td>
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<td><strong>CT</strong></td>
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<td>• T1 Hyperintense signal in a chronic disease (specific for TB)</td>
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<td>• destruction of the intervertebral disc space</td>
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<td>• increased signal of the disc on T2-W images</td>
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<td>• epidural, paravertebral and intraossseous abscesses</td>
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<td><strong>MRI</strong></td>
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abscess at thoracolumbar junction (petering abscess)

• In the lumbar region: bulging or indistinct psoas outline

Radiological changes evident with more than 50% bone loss.

cord and nerve root compromise

Subligamentous spread of pus (smooth margin unlike the pyogenic paravertebral abscesses have irregular margin and may destroy the paraspinal ligaments)

• Abscess: peripheral rim enhancement.
• Cord changes: high T2 signal (focal myelitis)

Signs of healing:

• regression of a lesion
• sclerosis and fusion of contiguous vertebral bodies
• reduction in the inflammatory soft tissue

PHEMISTER'S TRIAD:
• periarticular osteoporosis
• peripherally located osseous erosions
• gradual diminution of the joint space

Definitive diagnosis: aspiration
• Joint effusion
• Bone destruction, sequestrum formation, surrounding soft tissue extension

Other radiographic features:
• joint effusion
• lytic bone destruction.
• wedge-shaped areas of necrosis (kissing sequestra) on both sides of the affected joint.

Modality of choice for early detection
• Synovial proliferation hypointense on T2W images. (due to hemorrhage, inflammatory debris, fibrosis, and caseation necrosis.)

Definitive diagnosis: aspiration
• Bone destruction, sequestrum formation, surrounding soft tissue extension

Post gadolinium:
• synovial enhancement

• Chondral lesions and subchondral bone erosions (joint space still well preserved)
• Associated bone marrow edema
• Bone sclerosis and periostitis (late manifestation)

• End stage:

severe joint destruction eventually sclerosis and fibrous ankylosis.

Plain films may be negative early in the disease.

OSTEOMYELITIS (fig 9-11)

• soft tissue swelling
• minimal periosteal reaction, osteolysis (little or no reactive change)

• periarticular osteopenia, and erosions.

(Sclerosis is less common)

Multifocal tuberculous osteomyelitis

• Para-articular abscess:

Thin and smooth enhancing wall.

OSTEOMYELITIS

Accurate assessment of sequestrum

MARROW CHANGES:

T1W hypointense and

T2W :hyperintense

With post gadolinium enhancement

• NECROSIS:

hyperintense on T2W images with no enhancement.

• Gadolinium enhanced images for Deep soft
(osteitis cystica tuberculosa multiplex)

- in children: variable sized, well defined, osteolytic lesions (without sclerosis) variable size.
- metaphyseal expansion
- In adults: smaller lesions located in the long axis of bone, may show well-defined sclerotic margins.

Spina ventosa

- bone destruction
- overlying periosteal thickening
- fusiform expansion of the bone
- cyst-like tissue fistulae, sinus tracts, and abscesses evaluation.
cavities (expansion of the diaphysis and overlying soft tissue swelling).

**TENOSYNOVITIS**

Primary investigation

- tendon and synovial thickening
- synovial sheath effusion

- **Hygromatous stage:**
  - fluid inside the tendon sheath without sheath thickening.

- **Seros fibrinous stage:**
  - thickening of the flexor tendons and synovium, multiple tiny hypointense nodules within the hyperintense synovial fluid (T2W).

- **Fungoid stage:**
  - soft tissue mass involving the tendon and tendon sheath.

**BURSITIS**

(fig 12)

- osteopenia (hyperemia)
- focal osteolytic bone destruction (local)

- uniform distension of the bursa
**MYOSITIS**

(fig 13)

**Preferred modality for pyomyositis.**

- T1W: hypointense
- T2W: hyperintense

(abscess formation)

(abscess wall)

- Low signal intensity within the fluid-filled bursa on T2W images (caseous necrosis and fibrotic material)

(abscess peripheral rim)

- Enhancement on post contrast images

(abscess peripheral wall)

- Subtle hyperintensity on T1W images and hypointensity on T2W images.

(abscess calcified wall)

- Calcified wall of the distended bursa

(abscess pressure)

- Multiple small abscesses in the bursa.

(abscess pressure)

- Calcified wall of the distended bursa

(abscess pressure)
Conclusion

Tuberculosis is endemic in the Indian subcontinent and has also made a comeback in the industrialized nations with the rise in immunosuppressed population and drug resistance. Radiologists should be familiar with the imaging spectrum of musculoskeletal tuberculosis. Timely diagnosis of tubercular infection in the musculoskeletal system can reduce the morbidity seen in the natural course of the disease.

References


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