Extra-spinal musculoskeletal manifestations of mycobacterium tuberculosis (TB) infection: A review of radiological findings

Poster No.: P-0118
Congress: ESSR 2013
Type: Scientific Exhibit
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Keywords: Musculoskeletal bone, Musculoskeletal joint, Musculoskeletal soft tissue, MR, CT, Diagnostic procedure, Infection, Abscess
DOI: 10.1594/essr2013/P-0118

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Purpose

TB infection is a major public health problem around the world. In recent years there has been a rise in the prevalence of TB in many parts of Europe as a result of migration, a growing number of immunocompromised patients and various socioeconomic factors. The musculoskeletal system is involved in 1-3% of cases and of these only 50% involve the extraspinal bones and soft tissues. Isolated soft tissue TB is extremely rare. Diagnosis can be difficult as extraspinal musculoskeletal TB often has an indolent, non-specific presentation. The index of suspicion is often low as active pulmonary TB is only seen in approximately 50% of patients. Whilst there are no pathognomonic imaging features of extraspinal musculoskeletal TB it is vital that radiologists are aware of the broad spectrum of appearances and sites of involvement so that specific laboratory tests can be carried out for confirmation.

Methods and Materials

We present a wide range of cases from our institution demonstrating a broad spectrum of extraspinal musculoskeletal manifestations of TB infection. The causative organism was confirmed by laboratory tests as mycobacterium tuberculosis in all cases. Examples include typical and atypical cases demonstrated with multiple imaging modalities including ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI). Specific cases include tuberculous myositis, tenosynovitis, septic arthritis and osteomyelitis including multifocal bone involvement.

Results

The musculoskeletal (MSK) system accounts for 25% of cases of extra-pulmonary TB and 3% of all TB infections [1]. MSK involvement is most commonly a result of haematogenous spread from primary lung infection or by reactivation in a bone or joint. Immunosuppression, as a result of disease or drug therapy, is the commonest predisposing condition and pre-existing joint disease is also a risk factor.

The clinical manifestations of MSK TB are often indolent and non-specific in nature, making diagnosis difficult unless the clinical setting arouses suspicion of TB. The fact that less than 50% of patients have co-existing active pulmonary TB may also contribute to delays in reaching the diagnosis. Once TB is suspected, confirmation from tissue biopsy or aspirate can also prove to be problematic as the detection rate from staining and microscopy is low, whilst microbiology culture results can take 6-8 weeks.
Left untreated, MSK TB can result in significant joint deformity and permanent disability, underlining the importance of early recognition and a low threshold for confirmatory investigations. Although it is seldom possible to definitively make a diagnosis of TB on imaging alone, certain characteristic features, in the appropriate clinical setting, should alert the radiologist to the possibility of TB being the underlying cause.

Most cases (50-70%) of MSK TB affect the spine, whilst 30% involve peripheral joints. TB infection of soft tissues, including tenosynovitis, pyomyositis and bursitis are particularly rare [Table 1 on page 26]. The imaging features of tuberculous spondylodiscitis are well known but extraspinal disease is less frequently encountered and so less familiar. The aim of this presentation is to provide a pictorial review of these less common manifestations of MSK TB infection.

Table 1: Distribution of different sub-types of musculoskeletal TB. [1]

References: Radiology Department, Royal Free Hospital - London/UK

**TB OSTEOMYELITIS**

The clinical features of tuberculous osteomyelitis are non-specific. Although pain and swelling may be presenting symptoms, often the clinical course is insidious with minimal pain and either low-grade or no fever, as opposed to pyogenic osteomyelitis where the typical features of acute sepsis are invariable. Any bone can be affected, although in children lower limb metaphyseal infection and involvement of the phalanges (tuberculous dactylitis) of the hands and feet are more common.

Plain radiographs may be normal in the early stages, whilst in chronic infection appearances are often similar to pyogenic osteomyelitis, although periosteal reaction may be more subtle and sequestration is rare. Soft tissue swelling is common and there may be erosions and peri-articular osteoporosis [Fig. 1 on page 7]. These features are non-specific and can mimic other diseases.
Magnetic resonance imaging (MRI) may demonstrate replacement of normal bone marrow signal with low T1-weighted and high T2-weighted signal intensity. Gadolinium contrast enhancement may be seen on T1 weighted sequences in the marrow and adjacent soft tissues, whilst areas of necrosis show no enhancement [ ]. An extraosseous inflammatory mass or abscess may be seen overlying the affected bone.

Some lesions follow a disease pattern with features more characteristic of TB osteomyelitis [1].

Cystic lesions are round or oval lucent eccentrically located lesions with a breach in the cortex and subtle marginal sclerosis. These are more common in children and immunosuppressed adults. They can be uni- or multi-focal, with the latter also called osteitis cystica tuberculosa multiplex [ Fig. 3 on page 9 ].

Spina ventosa (latin - spina, a short bone; ventosa, inflated with air) is the name given to a lesion which occurs in the small bones of the hands and feet in cases of TB dactylitis, appearing as an expansible lytic lesion with overlying periosteal thickening.

Infiltrative lesions can be focally or diffusely destructive, or may follow a permeative pattern, and can therefore easily be misdiagnosed as aggressive bone tumours [ Fig. 4 on page 10 , Fig. 5 on page 11 ].

Expansile or destructive lesions can result in pathological fractures, which often go on to delayed or non-union [ Fig. 6 on page 12 , Fig. 7 on page 13 ].

**TB ARTHRITIS**

TB infection of joints accounts for 30% of all musculoskeletal TB. As with all joint infections it is usually monoarticular, with the hip and knee most commonly affected [2]. The disease usually spreads to the joint from a nearby metaphyseal focus of osteomyelitis. This transphyseal route of spread is unique to TB, occurring exceedingly rarely in pyogenic infection. Haematogenous spread of the bacillus directly to the joint synovium is a less common occurrence.

Patients present with non-specific symptoms of joint pain and swelling which may have been present for many months. In patients who are deemed to be at risk of TB infection, chronic arthritis which fails to respond to other therapy should be rigorously investigated to exclude TB.
The radiographic features are non-specific and mimic other inflammatory arthritides. Plain radiographs may demonstrate the classic components of Phemister's triad - periarticular osteoporosis, marginal erosions and gradual joint space narrowing. It should be noted however that the joint space remains relatively well preserved until the later stages of disease. Untreated TB arthritis results in complete joint destruction and ankylosis [Fig. 8 on page 14, Fig. 9 on page 15].

Joint effusion is an early finding and is easily demonstrated on ultrasound, which can also be used to guide joint aspiration for diagnostic purposes. Computed tomography (CT) may show bony destruction, sequestration and extension into adjacent soft tissues.

MRI is the modality of choice for demonstrating early disease, particularly changes in the synovium, when plain radiographs may be normal. Infected synovium is initially thickened, and has a variable signal intensity on T1-weighted imaging but is characteristically of low or intermediate intensity on T2-weighted sequences. Intense enhancement of the synovium is seen on gadolinium enhanced T1-weighted images. The inflamed tissue may have a heterogenous appearance due to the combination of acute synovitis, necrosis and chronic fibrosis.

Bone erosions are well demonstrated on MRI and may exhibit T2-hyperintense areas adjacent to them, which represent oedema or osteomyelitis. Para-articular abscesses are common and have smooth, low T2-intensity margins often accompanied by minimal inflammatory change, when they are termed cold abscesses. There may be a sinus tract, seen as an area of hyperintense signal on T2-weighted images with marginal enhancement, the so-called "tramtrack" enhancement [3].

The appearance of joint effusion may be heterogenous on T2-weighted images due to the presence of necrotic synovial debris, fibrinous tissue and occasionally rice bodies. These lesions are so called because of their appearance being similar to grains of rice, and although they are a key characteristic of TB infection they can also occur in other forms of chronic synovial disease such as rheumatoid arthritis [Fig. 10 on page 16, Fig. 11 on page 17].

**TB TENOSYNOVITIS**

Tuberculous tenosynovitis is usually the result of haematogenous spread from other sites or due to direct extension from an infected joint. Primary TB tenosynovitis most commonly affects the flexor tendons of the hand and is extremely rare [Fig. 12 on page 18, Fig. 13 on page 19].
Plain radiography is often normal but may demonstrate soft tissue swelling along the line of the tendon sheath. Ultrasound is an ideal first line imaging modality, demonstrating thickening of the tendon, synovial sheath or both. As with other forms of chronic tenosynovitis there is usually relatively little fluid within the sheath, unlike in acute pyogenic infection where large fluid collections are typical [4].

MRI appearances are variable and depend on the stage and extent of disease. Three progressive stages have been described [5]:

- **Hygromatous stage** - serous fluid in tendon sheath without thickening of the sheath itself
- **Serofibrinous stage** - thickening of flexor tendons and synovium with multiple tiny hypointense nodules (rice bodies) within the hyperintense synovial fluid on T2-weighted images
- **Fungoid stage** - formation of a soft tissue mass involving the tendon and tendon sheath

Progression of disease results in eventual extension to adjacent soft tissues, bones and joints.

**TB MYOSITIS**

TB infection of the muscles or deep fascia is uncommon and is usually seen in immunosuppressed patients. Most cases occur as a result of local extension from adjacent lymphadenopathy, arthritis or osteomyelitis. Direct invasion of the chest wall from pleural disease or thoracic lymphadenopathy is one example. Cold abscesses in the psoas muscles can arise from lumbar spondylodiscitis [Fig. 14 on page 20, Fig. 15 on page 21]. In cases of myositis it is important to rigorously seek evidence of bone involvement. *Primary* infection via haematogenous or lymphatic routes is extremely rare [4] [Fig. 16 on page 22, Fig. 18 on page 24, Fig. 17 on page 23, Fig. 19 on page 25].

The role of plain radiography is limited but loss of soft tissue planes may be seen. Ultrasound demonstrates soft tissue and intramuscular oedema, and there is often an associated fluid collection which can be aspirated under ultrasound guidance. CT is useful for detection of bony involvement and for imaging deep-seated collections. These have necrotic, hypodense centres and demonstrate rim enhancement on post-contrast images.

MRI is the optimal imaging modality for myositis due to the high resolution of soft tissues and lack of radiation, an important factor to consider as patients often require serial
imaging to assess response to treatment. Lesions show high T2-weighted and low T1-weighted signal with irregular enhancement of the abscess walls. Diffusion-weighted imaging shows a restricted pattern.

Images for this section:
Fig. 1: Plain radiograph of the right ankle of a 36 year old woman who presented with ankle pain. There is a lucent lesion in the medial tibial metaphysis with thinning of the cortex, subtle periosteal reaction and faint calcification in the adjacent soft tissue. Subsequent investigation confirmed this to be TB osteomyelitis.
Fig. 2: Gadolinium enhanced T1-weighted fat saturation MRI imaging of the same patient as in Fig 1. (a) and (b) sagittal,(c)coronal and (d) axial views. There is intense ring enhancement of the intraosseous tibial lesion, which communicates with an abscess in the overlying soft tissue. Disease has extended to involve the adjacent ankle joint, which is typical.
Fig. 3: Axial CT image of the pelvis of a 30 year old woman who presented with chronic polymyalgia, night sweats and fatigue. There are multiple lytic lesions in both iliac bones and the sacrum. Note the pathological fracture through one lesion in the left ischial tuberosity. CT guided biopsy confirmed TB infection.
Fig. 4: Plain radiographs of the right hand. This 32 year old man gave a history of longstanding pain in the right hand. There is an ill-defined permeative lesion in the distal second metacarpal bone, with associated periosteal reaction and soft tissue swelling. MR imaging was subsequently performed (see Fig.5).
**Fig. 5:** The same patient as in Fig 4. Coronal (left) and axial (right) gadolinium enhanced T1-weighted fat-sat MRI images. There is intense enhancement of both intraosseous and soft tissue components of the lesion, with a central necrotic core. The soft tissue abscess can clearly be seen to communicate with the bone lesion, and note its heterogenous appearance due to necrotic debris and fibrinous material within it.
Fig. 6: Plain radiographs of the right hand of a 26 year old woman who presented following a minor episode of trauma. On the initial radiographs (left) there is a fracture through the lucent lesion at the base of the middle finger proximal phalanx, which was suspected to be an enchondroma. The two radiographs on the right were taken when she attended for surgical treatment of the lesion, which had enlarged with accompanying periosteal reaction and severe soft tissue swelling. Biopsy confirmed TB.
Fig. 7: TB osteomyelitis. (a) Ultrasound image; (b), (c), (d) sagittal, coronal and axial gadolinium enhanced T1-weighted fat-sat MR images of the right hand. This man presented with cellulitis of the hand. Plain radiographs showed a partially healed diaphyseal fracture of the 4th metacarpal bone. Ultrasound demonstrated a subcutaneous fluid collection. MRI shows high signal intensity within the 3rd and 4th metacarpal bones and extensive enhancement in surrounding soft tissue. Several ring enhancing abscess pockets can be seen in communication with the affected bone.
Fig. 8: TB arthritis of the wrist. AP and lateral plain radiographs of the right hand. This 28 year old patient presented with a history of chronic right wrist pain. No other joints were symptomatic. There is extensive degenerative change affecting the radiocarpal joint and destructive arthropathy of the carpal joints.
Fig. 9: The same patient as in Fig 8. Gadolinium enhanced T1-weighted fat-sat sagittal (left) and coronal (right) images. There is intense enhancement of the thickened wrist joint synovium, erosive arthropathy affecting the radiocarpal, radioulnar and carpal joints and marked bone marrow oedema in the involved bones. Note the enhancing fluid collection in the extensor tendon sheath (arrow). US guided biopsy confirmed TB infection.
**Fig. 10:** TB arthritis of the knee. Proton density weighted sagittal MRI image. This 71 year old man had a history of chronic knee arthritis which had failed to respond to anti-inflammatory therapy. There is degenerative arthropathy and the synovium is thickened. The key finding in this case is of the low signal loose bodies in the synovial effusion (arrows) which are rice bodies. Though not unique to TB infection, these are a characteristic feature of it.
Fig. 11: The same patient as in Fig 10. Full sagittal PD-weighted MRI images. There is extensive degenerative change, synovial thickening and a large effusion seen in both the suprapatellar and posterior aspects of the knee with rice bodies suspended within it.
Fig. 12: TB tenosynovitis of the hand flexor tendons. Transverse (top) and longitudinal (bottom) ultrasound images. The transverse views demonstrate enlarged, heterogenous appearing tendons with neovascularity within them. There is thickening and effusion within the tendon sheath on the longitudinal views.
Fig. 13: TB tenosynovitis. T2-weighted axial imaging of the hand. There is diffuse high signal in the flexor tendon sheaths of the 2nd and 3rd digits. A fluid collection can be seen between the affected digits. In this case there was no evidence of bony involvement, which is a rare occurrence.
**Fig. 14:** Tuberculous psoas muscle abscesses. (a) T1-weighted sagittal, (b) gadolinium enhanced T1-weighted coronal and (c) T2 weighted coronal images of the lumbar spine. Psoas abscesses are a common complication of TB spondylodiscitis, as in this case. The abscesses appear as low T1 and high T2 signal intensities within the muscle, often in communication with the paraspinal inflammatory mass arising from the spinal disease.
Fig. 15: Bilateral psoas abscesses. Gadolinium enhanced T1-weighted axial MRI images of the same patient as in Fig 15. Note the lack of contrast enhancement in the necrotic centres of the intramuscular 'cold' abscesses.
Fig. 16: TB myositis. Transverse ultrasound image of the left thigh. This patient was immunosuppressed following a renal transplant and presented with fever and left thigh pain. Large heterogenous masses were seen in his thighs bilaterally on ultrasound. Biopsy during the same examination later confirmed tuberculous infection.
**Fig. 17**: TB myositis. The same patient as in Fig 16. Axial CT scan images show large low attenuation collections within the medial thigh muscles bilaterally. Although soft tissue infection is better defined on MR imaging, CT is useful to assess for bony involvement, of which there was none in this case.
Fig. 18: TB myositis. The same patient as in Fig 16. Gallium SPECT scan showed areas of increased uptake predominantly in the adductor compartments of both thighs.
Fig. 19: TB myositis. The same patient as in Fig 16. Axial Gallium SPECT images. Nuclear medicine imaging is playing an increasingly important role in MSK TB, in terms of identifying the extent of disease, the degree of activity of the disease process, and sometimes in differentiating from other conditions where there is diagnostic uncertainty.

<table>
<thead>
<tr>
<th>Sub-type</th>
<th>TB spondylitis</th>
<th>TB arthritis</th>
<th>TB osteomyelitis</th>
<th>Calvarial / middle ear TB</th>
<th>TB of soft tissues</th>
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<tr>
<td>Prevalence (as a % of all MSK TB)</td>
<td>50%</td>
<td>30%</td>
<td>3-19%</td>
<td>Up to 3.7%</td>
<td>Rare</td>
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</table>
Table 1: Distribution of different sub-types of musculoskeletal TB. [1]
Conclusion

TB poses unique diagnostic challenges for all clinicians, as it often has an indolent, non-specific presentation and can mimic other diseases, both in terms of clinical presentation and radiology. As a result of the resurgence of TB in many parts of Europe, it is important for radiologists at all levels to be aware of the wide range of ways in which this disease can present, particularly in view of the potential for permanent deformity and disability if left untreated. We hope this presentation has provided the reader with an overview of the spectrum of ways in which TB infection can affect the extraspinal musculoskeletal system.

References


Personal Information