Pott's Spine: Retrospective Analysis of MRI in 40 Cases.

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Authors: R. Avantsa, P. Kala, D. V. Bhargavi; Bangalore/IN
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Learning objectives

Magnetic resonance imaging is a powerful diagnostic tool to evaluate spinal infection and to help distinguish between an infection and other clinical conditions.

Learning objectives:

* To analyze the patterns of Koch's spine based on the anatomical location.
* To describe the key MRI features of the tubercular spine.
* To illustrate the different patterns in different practical cases.


**Background**

**Introduction**

Tuberculosis (TB) was known lethal disease prior to the development of the antibiotics before 1950s, which thereafter showed a steady fall in incidence. However, Tuberculosis is still remained endemic in developing countries wherein poverty, malnutrition and the presence of drug resistant strains aid in spread of the disease.

In addition there is resurgence of the disease since mid-1980s in developed countries, mainly in immigrants from countries where the disease is prevalent and in patients with immunodeficiency diseases or chronic diseases like DM, chronic renal failure, COPD, cirrhosis of the liver, leukemia, and lymphoma.

The other factors contribute to this resurgence of the disease are growing elderly population, poor living conditions, poor nutrition status, alcohol and drug abuse.

*TB involves both pulmonary and extrapulmonary sites.*
*The incidence of the skeletal tuberculosis is 1-5% of the patients with tuberculosis.*
*In developing countries the skeletal tuberculosis is most common in children whereas in industrialized countries adults are commonly affected.*
*There is no predilection for either sex.*

Koch's spine or spinal tuberculosis is the most important skeletal presentation of the disease. **Percival Pott** presented the classic description of spinal tuberculosis (TB) in 1779. Hence, spinal TB was called 'Pott's Disease'.

*It constitutes about 50% of the musculoskeletal tuberculosis.*
*In developing countries the presentation is common in children and young adults and is more aggressive in extension and abscess formation.*
*Consequently the neurological complications and deformities are frequent.*
The varied presentation, serious complications and association of the spinal tuberculosis with immunodeficiency and chronic health diseases warrants its inclusion in the differential diagnosis in spinal disorders.

MR imaging is currently the modality of choice for the evaluation of potential spinal infections and spinal disorders.

*The advantages of MR imaging over other modalities include capability of multiplanar imaging, direct evaluation of the bone marrow and simultaneous visualization of the neural structures.

**Pathology and pathogenesis**

- Tuberculosis is caused by a bacillus, *Mycobacterium tuberculosis*.
- Spinal tuberculosis is usually secondary to the primary or reactivated infective focus either from the lung or genitourinary system.
- Spread of the infection to the spine is through hematogenous in most of the instances.
- Other types of spread are from paraspinal infection and lymphatic spread from adjacent structures like pleura or kidney.
- Tuberculosis infection is characterized by a delayed hypersensitivity immune reaction.

- In the vertebrae the granulomatous lesion develops containing central caseating necrosis, multinucleated giant cells, epitheloid cells and peripheral lymphocytes.
- The inflammatory reaction with formation of granulation tissue causes bone expansion and trabecular destruction, progressive demineralization, bone destruction and in later stages cartilage destruction with involvement of adjacent disc space.
- The osseous lytic lesions with distinct margins show no bone regeneration or periosteal reaction, which eventually undergoes fibrosis, sclerosis and ankylosis in chronic stages.
- The proliferative granulation tissue causes thrombosis of the vessels, tissue necrosis and breakdown of the inflammatory cells results in paraspinal abscess.
- The pus may localize or track along the tissue planes. Progressive necrosis of the bone leads to kyphosis.
- Typically the infection begins in the anterior aspect of the vertebral body adjacent to the disk. The infection then spreads to the adjacent vertebral bodies under anterior longitudinal ligament.
• Noncontiguous (skip) lesions are also seen.

Site of infection:

Most frequent site of involvement of spinal tuberculosis is the thoracolumbar junction (fig 1). The frequency of incidence of the infection is low above and below this level.

Pattern of spine involvement (figure 2)

Ø Typical presentation-
Involvement of contiguous vertebrae with extension into the intervertebral disk.

Ø Atypical presentation-
· Involvement of noncontiguous vertebrae with no evidence of involvement of intervertebral disk.
· Isolated involvement of the posterior spinal elements.

Pattern of vertebrae involvement (fig 3)

The primary focus can be in the vertebral body or in the posterior elements.

In the vertebral body three patterns of involvement is recognized.

1. Paradiskal
2. Anterior
3. Central.

Paradiskal lesions

• This is the most common pattern of spinal tuberculosis.
• The lesion is adjacent to the intervertebral disk (fig 3) leading to narrowing of the disk space.
• The narrowing of the disk space is either due to destruction of the subchondral bone with herniation of the disk into the vertebral body or direct involvement of the disk.
Anterior lesion

- This is a subperiosteal lesion under anterior longitudinal ligament (fig 3).
- The infection/pus spreads over multiple vertebral segments resulting in stripping of the periosteum and anterior longitudinal ligament from the anterior surface of the vertebrae.
- The stripping of the periosteum renders the vertebrae avascular and susceptible to infection. The ischemia and pressure causes anterior scalloping of the vertebrae.

Central lesion: (fig 3)

- This lesion is centered in the vertebral body.
- There is vertebral collapse leading to formation of vertebra-plana appearance.
- There is no involvement of the disk.

Posterior spinal elements lesion: (fig 2, 3)

- This is infrequent presentation.
- The lesion is seen in pedicle, laminae, spinous process or articular processes.
- There is erosion or abscess formation.

Skip lesions (Fig 2,3)

- Noncontiguous vertebral body involvement without involvement of intervening disk.
- This is a rare presentation.

Complications of TB spine (Fig 4):

- The most serious complications include paraplegia or quadriplegia which are seen in 10% of the patients.
- Cord compression is another complication due to either epidural abscess or granulation tissue or in combination with vertebral collapse, subluxation, or dislocation.
- Rarely results in meningomyelitis due to penetration of pus into dura.
Fig. 1: Various locations of the infection in the spine

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Fig. 2: Location of lesions in the vertebral bodies.

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Fig. 3: Various patterns of vertebral lesions.

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Fig. 4: Associated collections and complications of TB spine.

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Findings and procedure details

Materials and methods

We retrospectively analyzed MR images of 40 patients of proven spinal tuberculosis who attended our hospital during 2011 to 2014. The pattern, extent, soft tissue involvement and associated MRI features were studied.

Magnetic Resonance Imaging

MRI spine was taken using a 1.5Tesla Philips Achieva machine.

The sequences that were performed in our hospital for all cases of spine imaging are, T1W, T2W, STIR and contrast enhanced fat suppressed T1W images Gadodiamide at a dose of 0.1mmol per kilogram of body weight was used as an intravenous contrast agent.

- The following sequences were done.
- Sagittal T1W [repetition time (TR)/echo time (TE) 427/18msec]
- Sagittal STIR (short tau inversion recovery)- (3500/80 ms)
- Sagittal T2W (3276/116) fast spin echo (FSE) sequences
- Axial T2W (2845/120) FSE sequences
- Sagittal T1-weighted images (TR 300 to 500 milliseconds, TE 20 to 30 milliseconds) and axial T1-weighed sequences provided the anatomic details for a survey of the spine. Scan time was 1-2 minutes.

The parameters of T2-weighted imaging includes a TR of 2000 to 3000 milliseconds and a TE of 60 to 120 milliseconds; the acquisition time is 2 to 3 times longer than that of T1-weighted imaging.

Slice thickness 4 mm, and intersection gap 1 mm. FOV-301 mm

Results

Majority (n-28) of the patients were males (70%) and 30% were females.

35% of patients were in 21 to 30 age group and 60% (n-24) were below 40 years.
We classified spinal involvement according to the site of involvement of the spine. (figure 5)

- Cervical (10%),
- Thoracic (22.5%),
- Lumbar (25%),
- Sacral (2.5%),
- Cervico-thoracic (5%),
- Thoraco-lumbar (5%),
- Lumbo-sacral (12.5%),
- Sacro-iliac (2.5%),
- Whole spine (2.5%).

Further classified as typical and atypical presentations according to the site of lesion in the vertebral body and involvement of the intervertebral disk. (Table 1)

Most frequent presentation observed was involvement of the contiguous vertebrae (osteitis) with intervening disk (diskitis) (87.5%).

And among these the paradiskal involvement was most frequent 60% (n-21), followed by anterior 35.5% (n-10) and central 10% (n-4). (Table 1)

Atypical presentation observed was skip lesions (10%) and isolated posterior spinal involvement (2.5%). (Table 1)

Further the associated complications like fractures (5%), compressive myelopathy (17.5%), cord edema (5%), gibbus deformity (12.5%) were identified. (Table 2)

Additionally the soft tissue involvement was demonstrated according to the involvement or collection in the pre and para vertebral, epidural and psoas regions. (Table 3)

**Radiological (MRI) findings:**

On T1W sequence most of the lesions were hypointense with irregular vertebral endplates.

On T2W sequence the lesions were predominantly hyperintense, few heterointense with adjacent soft tissue hyperintensity.
On STIR sequence the collections, edema within and adjacent spine were more clear.

Post GAD fat suppressed T1W images showed peripherally enhancing collections, early phases of the infections and multiple vertebral lesions. And also cord edema was identified in one case (5%).

**Presentation of Pathologically proven cases with typical radiological (MRI) Features**

**Typical lesions**

Spondylodiskitis with involvement of the contiguous vertebra and intervertebral disk.

**Case 1.**

Pott's spine presentation as Cervical spondylodiskitis with abscess. (Figure 5)

50 year old male patient presented with neck pain and weakness in the bilateral upper limbs.

MR images showed typical lesion involving the contiguous vertebral end plates of C4 and C5, and intervening disk with disk space narrowing. There is associated mild anterior prevertebral collection, epidural collection cord compression. No evidence of cord edema or infection.

**Case 2.**

Pott's spine presentation as Thoracic spondylodiskitis with abscess. (figure 7)

A 41 year old male presented with low grade fever and upper back pain.

MRI revealed T5 and T6 vertebrae with end plate destruction, loss of disk space. There is anterior subligamentous extension of the collection with scalloping of anterior margin of the vertebral bodies. Epidural space collection together with posterior angulation of the vertebrae compressing the cord with cord edema and compression. Extension of the infection to the multiple contiguous thoracic vertebral is observed.

**Case 3.**

Pott's spine presentation as Lumbar spondylodiskitis with abscess.(figure 8)
A 75 year old male patient presented with history of paraplegia, bladder incontinence and low back pain. MR images revealed L4 and L5 vertebrae end plate destruction, diskitis, mild prevertebral and epidural collection.

**Case 4.**

Pott’s spine presentation as Sacral spondylodiskitis. (figure 9)

A 22 year old male patient presented with history of pain in the left lower back with pain during walking. MR images showed lesions in the sacral vertebrae with minimal prevertebral collection.

**Case 5.**

Pott’s spine presentation as Cervico thoracic spondylodiskitis.(figure 10)

MR images showed multiple cervical vertebral lesions (C3 to T1) with collapsed vertebrae (C3 and C4) compressing the thecal sac. There is associated cord compression.

**Case 6.**

Pott’s spine presentation as Thoracolumbar spondylodiskitis. (figure 11)

MR images showed T10 to L1 peripherally enhancing collections in the vertebrae, loss of T12-L1 disk space, nonenhancing prevertebral collection.

**Case 7.**

Pott’s spine presentation as Lumbosacral spondylodiskitis.(figure 12)

MR images showed L5 and S1 end plated destruction, narrow disk space, prevertebral collection and epidural collection.

**Case 8.**

Pott’s spine presentation as Sacroiliac tuberculosis. (figure 13)

MR images at different planes showed left sacral and iliac lesions with collection in the left SI joint. The right SI joint, right sacrum and Ilium are normal.
Pattern of lesions within the vertebrae.

Case 9.
Paradiskal lesions.(figure 14)
MR images reveal Paradiskal lesions in L3 and L4.

Case 10.
Anterior lesions.(figure 15)
MR image reveals anteroinferior lesion with lesions in the adjacent disk.

Case 11.
Central lesions.(figure 16)
MR images reveal central lesion of L5 vertebral body with collapse. This patient had presented with neurogenic bladder. There is chronic sinus tract formation extending posteriorly into the subcutaneous plane.

Atypical lesions

Case 12.
Skip lesions. Multiple non-contiguous vertebral Involvement.(figure 17)
MR images showed multiple enhancing lesions in the thoracic and lumbar vertebra and in the L1 posterior spinal elements. The CT guided biopsy from the spinous process lesion confirmed tuberculosis.

Case 13.
Isolated posterior spinal elements tuberculosis. (figure 18)
MR images reveal lesions in the laminae and spinous process of thoracic vertebrae involving two contiguous vertebrae. There is no involvement of the vertebral bodies. There is narrowing of the bony spinal canal.

Associated collections and complications
**Case 14.**
Pre and epidural abscess. (figure 19, 21)

MR images showed thoracic and lumbosacral vertebral lesions with anterior prevertebral subligamentous collection, epidural thickening and collection. There is stenosis of the spinal canal with cord compression.

**Case 15.**
Psoas abscess (figure, 20)

MR images showed thoracolumbar typical vertebral peripherally enhancing lesions and right psoas collection.

**Case 16.**
Cord edema and cord compression. (figure 21)

MR images showed typical spondylodiskitis lesion, prevertebral, epidural collection with spinal canal stenosis, cord compression and signal intensity changes in the cord at the same level.

**Case 17.**
Vertebral body fracture with Gibbus deformity (figure 22)

MR image revealed destruction and anterior erosion of the T12 and L1 vertebral bodies with posterior angulation and deformity.
**Fig. 5**: Pie chart showing distribution of the presentation of spinal tuberculosis.

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<th>Location of the lesion within the vertebra</th>
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**Table 1:** Distribution of lesion pattern.

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<td>Associated with complications</td>
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<td>40</td>
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<tr>
<td>2</td>
<td>No associated complications</td>
<td>24</td>
<td>60</td>
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**Types of complications**

| 1   | Compressive myelopathy            | 7           | 43.75             |
| 2   | Gibbus deformity                   | 5           | 31.25             |
| 3   | Cord edema                         | 2           | 12.5              |
| 4   | Fractures                          | 2           | 12.5              |

**Table 2: Associated complications**

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<td>38</td>
<td>95</td>
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<tr>
<td>2</td>
<td>Without collections</td>
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**Site of collections**

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<th>Percentage (100%)</th>
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<td>8</td>
<td>21.05</td>
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<tr>
<td>2 Pre /+ Paraspinal + Psoas</td>
<td>11</td>
<td>28.94</td>
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<td>34.21</td>
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<tr>
<td>4 Pre /+ Paraspinal + Psoas + Epidural</td>
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<td>15.79</td>
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**Table 3:** Associated collections

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**Fig. 6:** STIR and post GAD T1W Sagittal images showing typical lesion involving the contiguous vertebral end plates of C4 and C5, and intervening disk with disk space narrowing. There is associated mild anterior prevertebral collection, epidural collection cord compression. No evidence of cord edema or infection

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**Fig. 7:** T2W Sagittal image showing signal intensity changes in T5 and T6 vertebrae with end plate destruction, loss of disk space. There is anterior subligamentous extension of the collection with scalloping of the vertebral bodies. Epidural space collection together with posterior angulation of the vertebra compressing the cord with cord edema and compression. Extension of the infection to the multiple contiguous thoracic vertebral is seen.

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**Fig. 8:** T2W and STIR Sagittal images revealing signal intensities changes in the L4 and L5 vertebrae (hyperintense), end plate destruction, diskitis, mild prevertebral and epidural collection.

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**Fig. 9:** STIR Sagittal and T2W axial images showing hyperintense lesions in the sacral vertebrae with minimal prevertebral collection.

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Fig. 10: Sagittal STIR image showing multiple cervical vertebral hyperintense lesions (C3-T1) with collapsed vertebrae (C3 and C4) compressing the thecal sac. There is associated cord compression.

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Fig. 11: Sagittal STIR, T2W and T1W post GAD images showing T10-L1 vertebral hyperintense lesions with peripheral enhancement in post GAD images, loss of T12-L1 disk space, nonenhancing prevertebral collection.

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Fig. 12: Sagittal T1W, T2W and STIR images showing L5 and S1 end plated destruction narrow disk space, prevertebral collection and epidural collection. The lesion is hypointense on T1W images.

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**Fig. 13:** T2W Coronal images at different planes showing left sacral and iliac lesions with collection in the left SI joint. The right SI joint, right sacrum and Ilium are normal.

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Fig. 14: Sagittal images of thoracic spine (T1W, T2W, Post GAD T1W and STIR in clockwise direction from left top) showing Paradiskal lesions with disk space narrowing which is a typical presentation of tuberculosis spine.

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**Fig. 15:** Sagittal T2W image reveals anteroinferior lesion with signal intensity changes in the disk.

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**Fig. 16:** T2W Sagittal and coronal images reveal central lesion of L5 vertebral body with collapse. This patient had presented with neurogenic bladder. There is chronic sinus tract formation posteriorly into the subcutaneous plane.

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Fig. 17: Sagittal images of T2W, STIR and post GAD show multiple enhancing lesions in the thoracic and lumbar vertebra and in the L1 posterior spinal elements. The CT guided biopsy from the spinous process confirmed tuberculosis.

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Fig. 18: T1W and post GAD images reveal lesions in the laminae and spinous process of thoracic vertebrae involving two contiguous vertebrae. There is no involvement of the vertebral bodies. There is narrowing of the bony spinal canal.

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Fig. 19: Sagittal T2W Cervico thoracic and STIR lumbosacral spine reveal typical lesions of vertebral osteitis and diskitis of thoracic, L5 and S1 with prevertebral collection.

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**Fig. 20:** Coronal T2W and post GAD T1W images show peripherally enhancing lesions in the T11, T12 and L1 with similar lesion in the right psoas.

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Fig. 21: T2W Sagittal image shows typical spondylodiskitis lesion with prevertebral, epidural collection with spinal canal stenosis, cord compression and hyperintensity in the cord at the same level.

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**Fig. 22:** Sagittal T2W image reveals destruction and anterior erosion of the T12 and L1 vertebral bodies with posterior angulation and deformity.

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Conclusion

Conclusion:

Magnetic resonance imaging (MRI) is the diagnostic modality of choice for Pott's spine and is more sensitive than other modalities and is the best in identifying the different patterns, the soft tissue involvement, associated complications and cord abnormalities.
Personal information

Dr Rohini Avantsa, MD.
Department of radiology, Vydehi institute of medical sciences, Bangalore, India.
rkgayatri5@gmail.com

Dr Prachi Kala, MD.
Neuroradiology Division, Department of radiology,
Vydehi institute of medical sciences, Bangalore, India.
prachi_kala@yahoo.com

Dr Vidya Bhargavi,
Resident, Department of radiology, Vydehi institute of medical sciences, Bangalore, India.
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