Original Article

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Spectrum of Imaging Findings of Spinal Tuberculosis on Magnetic Resonance Imaging

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Abstract

Background: To describe the spectrum of manifestations of spinal tuberculosis on Magnetic Resonance Imaging. To study the role of MRI in assessing the extent of disease and in the decision-making process. **Subjects and Methods:** It is a prospective study conducted at the department of Radiodiagnosis in Narayana Medical College and Hospital, Nellore. The study was carried out on 63 cases of spinal tuberculosis in the period of two years (August 2019 to august 2021). MRI features were observed on T1 Weighted, T2 Weighted and short tau inversion recovery (STIR) sequences. Diagnosis was based on the history, clinical features and characteristic radiological findings on MRI along with the response to the treatment. **Results:** Spinal tuberculosis was most commonly seen in young adults and of male predominance. Backache in 58(92%) and low-grade fever were found to be the most common clinical features followed by weight loss and paraparesis. Thoraco-lumbar spine was the most commonly involved in 26(41.2%), followed by thoracic, lumbar and sacral vertebrae. MRI findings included bone marrow edema in 63(100%), end plate irregularities in 63(100%), disc space reduction in 34(53.9%), pre and paravertebral collection in 26(41.2%), calcification in 25(39.6%), spinal cord compression in 18(28.5%). In patients with spinal cord compression exceeding more than 20%, neurological symptoms were seen. Vertebral body wedge collapse in 33(52.3%), compression fracture in 14(22.2%) and both vertebral body wedge collapse with compression fracture were noted in 5 (7.9%). Kyphotic deformity in 25 (39.6%) and scoliosis in 8(12.6%) was also noted. In the majority of cases, a paradiscal pattern of involvement was found. **Conclusion:** Spinal tuberculosis is best evaluated on the Magnetic Resonance Imaging as it provides valuable and critical information regarding the spectrum, ranging from simple edema involving the vertebrae, intervertebral discs to the paraspinal collections, abscesses and vertebral collapse leading to spinal cord compression in patients with neurological deficit and thereby limiting the morbidity and helping in early diagnosis and guiding the management.

Keywords: Imaging, Spinal Tuberculosis, Magnetic Resonance Imaging.

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Introduction

Tuberculous spondylitis also known as Pott disease, refers to the vertebral body osteomyelitis and intervertebral discitis from Tuberculosis. The disease was first classically described by Percival Pott in the year 1778 and hence referred to as Pott disease.[1,2,3,4]

Among the extrapulmonary sites of tubercular infection, spinal tuberculosis is the most common site, most frequent location of musculoskeletal tuberculosis and accounts for 50% of all the cases of skeletal tuberculosis.[1] Tuberculosis is one of the oldest diseases that is known to mankind and even to this date, there is significant prevalence and morbidity of this condition especially in the developing countries.[5,6,7]

Although the thoracolumbar junction seems to be the most common site of the spinal column involvement in spinal TB, any part of the spine can be affected. Furthermore, the incidence of neurologic complications in spinal TB varies from 10% to 43%.[8,9,10,11,12,13]

Risk factors/ Predisposing factors

- Overcrowding
- Poverty
- Malnutrition
- Improper implementation of anti-tubercular treatment
- Illiteracy
- Alcoholism
- Diabetes mellitus
- HIV infection

- Drug abuse
- Immunosuppressive treatment

Spinal involvement: Pathogenesis

Spread of Mycobacterium tuberculosis into the dense vasculature of cancellous bone of the vertebral bodies by hematogenous route.

- Pulmonary / Genitourinary Tuberculosis as the primary source.
- Infection can spread via the arteries i.e., Subchondral arterial arcade or via the venous route i.e., Batson's venous plexus
- As compared to older patients, Intervertebral discs are primarily and most commonly involved in the younger patients, because of good vascularity of intervertebral discs in younger individuals.[5,6]
- Intervertebral disc is not primarily involved in old age, because of its age-related avascularity.[5,6]

Clinical features

- back pain,
- low grade fever,
- loss of appetite,
- weight loss,
- paraparesis,
- bowel-bladder dysfunction,
- kyphotic deformity
- scoliotic deformity.

Plain radiographs in spinal tuberculosis are of use only up to a certain extent, because greater than 50% of the bone has to be involved and destroyed before a lesion can be seen, which takes nearly six months.

Computed tomography play's a major role in evaluating the disease extent and bone destruction patterns.[11] Narrowing of disc space, para-vertebral soft tissue abscesses with calcification within are seen, which are pathognomonic for tuberculosis.[11] However, without intravenous or intrathecal contrast material it is difficult to detect discitis, and epidural, thecal or spinal cord involvement.

Advantage of Magnetic Resonance Imaging is that, there will be improved and better contrast resolution of soft tissues and bone, along with versatility of direct imaging in multiple planes.[14,15,16,17,18] With the help of magnetic resonance contrast agents which are administered intravenously, granulation tissue and cold abscess can be distinguished with high accuracy.

We can prevent delay in the diagnosis and also limit the morbidity of this aggressive but curable infectious disease by being familiar with spectrum of Magnetic Resonance Imaging findings in Potts's spine.[2,10]

Spectrum of Spinal Tuberculosis	
BONE	-Paradiscal -Central -Anterior marginal -Skipped lesions -Posterior elements -C V junction
EPIDURAL	-Abscess/ -Granulation tissue
MENINGEAL	-Pachymeningitis -Leptomeningitis -Arachnoiditis -Spinal arachnoiditis Ossificans
SPINAL CORD	-Granulomas (Non-Caseating/ Caseating/ Calcified) -Myelitis -Intramedullary tubercular abscess

Types and Spread of Spinal Tuberculosis		
Type of involvement	Involvement mechanism	Radiological appearances
Paradiscal	Spread of disease is through the arteries	Adjacent margins of two consecutive vertebrae are involved. The disc space is reduced.
Anterior marginal	Abscess extension beneath the anterior longitudinal ligament and periosteum	Begins as a destructive lesion in one of the anterior margins of the vertebral body, minimally involving the disc space but sparing the vertebrae on either side
Posterior	Spread is through the posterior external venous plexus of vertebral veins or by direct spread	Involvement of posterior arch without the involvement of vertebral body.
Central	Spread of infection through the Batson's plexus of veins.	Involvement of central portion of a single vertebra. Proximal and distal disc spaces are intact.
Skipped lesions	Spread of infection along the Batson's plexus of veins	Circumferential involvement of two non-contiguous vertebral levels without any destruction of the adjacent vertebral bodies and the Intervertebral discs.

Aims and Objectives:

1. To describe the spectrum of manifestations of spinal tuberculosis on Magnetic Resonance Imaging.
2. To study the role of MRI in assessing the extent of disease and in the decision-making process.

Subjects and Methods

Place of study: Department of Radiodiagnosis, Narayana Medical college and Hospital, Nellore.

Type of study: Prospective study

Sampling method: Patients with clinical suspicion of spinal TB referred for MRI scan.

Inclusion criteria

- Patients with or without neurological deficit at spinal level with strong clinical suspicion of spinal tb.
- All age groups.
- Both sexes.

Exclusion criteria

- Trauma patients
- Patients with metallic implants

Technique- The MRI scan was performed on 3.0T GE MRI scanner. The following MRI sequences were studied: Sagittal and axial T1 weighted (T1 FSE), Sagittal and axial T2 weighted (T2 FSE), Coronal and sagittal STIR sequences followed by post-contrast T1 weighted sequences in axial, coronal and sagittal planes.

Postcontrast T1W sequences were obtained by using intravenous administration of Gd DTPA in a dose of 0.1 mmol/kg body weight.

On MRI various parameters observed were as follows:

Bone marrow oedema which was seen as hypointense signal on T1WI and hyperintense signal on T2WI.

Ischemic necrosis with vertebral body destruction was seen as an altered signal intensity in the vertebral body in both T1WI and T2WI images.

The end plate erosion which was seen as irregularities in the vertebral body endplates.

Loss of height of vertebral body was seen as a decrease in the average height of vertebral body when compared with the uninvolved adjacent normal vertebrae.

Disc height reduction was seen as a decrease in the average height of the disc when compared with the uninvolved adjacent normal discs.

Discitis was seen as hyperintense signal in T2WI within the disc along with loss of intranuclear cleft and/or reduction in the disc height and enhancement of the margins of the disc on post contrast T1WI.

Paravertebral collections were seen as hypointense signal on T1WI and hyperintense signal on T2WIthose extent and location were also noted.

Calcifications if present, in all the sequences were seen as signal void

Subligamentous infection spread was seen as abscess extension beneath the anterior longitudinal ligament.

The vertical extent and location of subligamentous collection were noted.

Epidural component was seen as canal encroachment /epidural indentation by pus/granulation tissue.

Epidural spread was seen as spread of pus beyond a single vertebral level within the vertebral canal outside the dura.

Results

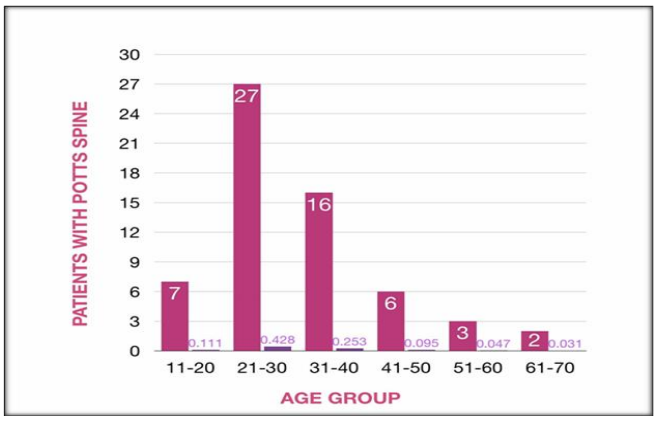

Figure 1: Bar chart showing age group of patients with spinal tuberculosis on x-axis and number of patients with their percentages on the y-axis

38 patients were males and 25 were females amongst a total of 63 patients who were diagnosed of having Pott's spine. The range of patient's age was between 11years and 70 years.

Young adults between the age group of 21-30 years (42.8%) constituted the maximum.

Clinical features of patients with Pott's spine included low grade fever, back pain, anorexia, paraparesis, loss of weight, bowel-bladder dysfunction, kyphosis and scoliotic deformity.

Amongst all the clinical features, back pain was the most common symptom, which was seen in about 58 patients (92%).

Chest radiograph was normal in most of the patients, with only 9 cases (14.2%) depicting pulmonary tuberculosis features.

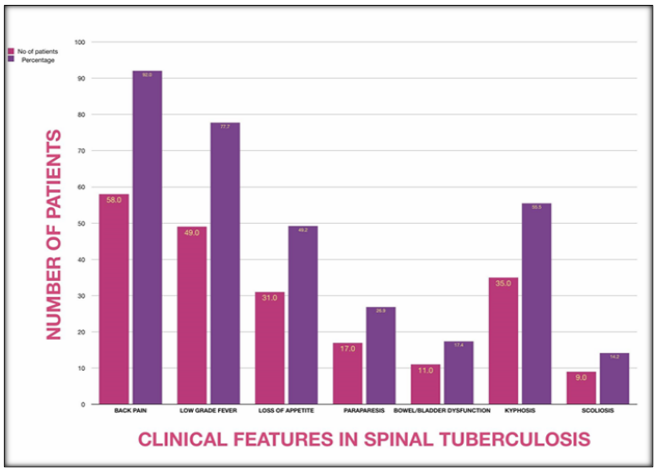

Figure 2: Bar chart showing clinical features of patients presented with spinal tuberculosis on x-axis and number of patients with their percentages on the y-axis.

Amongst the multiple sites of involvement in patients with Pott's spine, dorso-lumbar spine involvement was seen in majority of cases 25 cases (39.8%), which was followed by the dorso lumbar spine in 24 cases (38.2%), lumbar spine in

11 cases (17.5%), lumbo sacral spine in 2 cases (3.1%) and sacral spine in 1 case (1.5). Involvement of cervical spine was not seen in any of the cases.

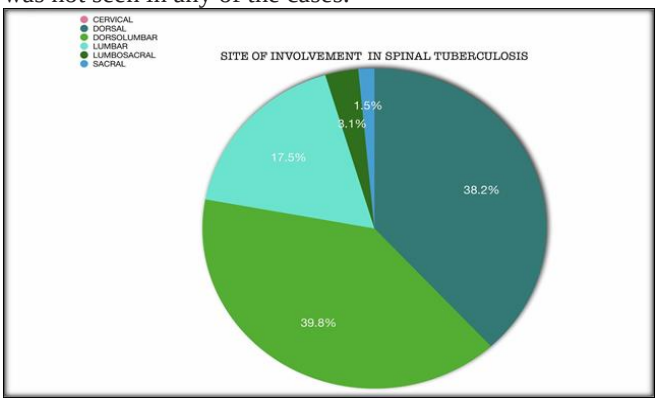

Figure 3: Pie chart showing different sites of involvement in patients with spinal tuberculosis in the form of percentages.

Amongst the different patterns of spinal involvement, the commonest was paradiscal type in 20(31.7%) which was followed by the central type in 15 (23.8%). In 16 (25%) patients, Anterior subligamentous involvement was seen and of all, the posterior elements were least commonly involved i.e.,8-cases (12.6%).

Table 1: The MRI findings have been depicted.

MRI parameters	No. Of patients (n=63)	Percentage (%)
Wedge collapse	33	52.3
Compression fracture	14	22.2
End plate irregularities	63	100
Bone marrow edema	63	100
Disc height reduction	34	53.9
Epidural collection	23	36.5
Intradural abscess	04	6.3
Pre &para vertebral abscess	26	41.2
Spinal cord edema	5	7.9
Spinal cord compression	18	28.5
Kyphosis	25	39.6
Scoliosis	8	12.6
Calcifications	25	39.6

Vertebral body destruction was seen in majority of patients (52) with wedge collapse in 33 (52.3%), compression fracture in 14 (22.2%) and both in 5(7.9%) cases. End plate irregularities and bone marrow edema were found in all patients, while disc height reduction was found in 34(53.9%).

Degree of spinal canal compression was noted to be between 15 to 65% and was seen in 18 (28.5%) patients. Neurological deficit was seen in 28 patients. In patients with spinal canal compression exceeding 20%, neurological symptoms were found.

Cases and Illustrative Figures

Figure 4: MRI revealed altered marrow signal intensity which is hyperintense on t2 and hypointense on T1in T2 and L2 and L3 vertebrae with involvement of adjacent intervertebral disc leading to anterior wedge compression collapse of L2 and L3 vertebrae. Posteriorly there is soft tissue component seen protruding into the epidural space causing compression of cord and displacing it posteriorly with secondary narrowing of lumber canal.

Figure 5: Mri study of lumbosacral spine in a 56 year old male patient who came with C/O low back pain and fever, shows on sagittal T1WI (A) and T2WI (B) evidence of bone marrow edema with endplate and IV disc destruction at L5-S1 level with associated large epidural abscess causing indentation of the thecal sac and compression of the traversing nerve roots. Small prevertebral abscess is also noted.

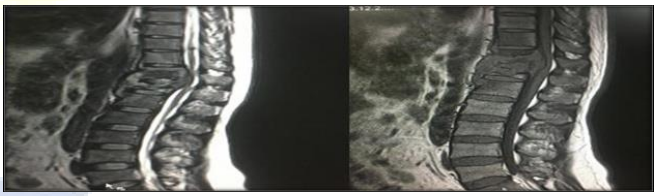

Figure 6: a 45 year old male with back pain, fever and weight loss, there is evidence of altered signal intensity with paradisical destruction of D11 and D12 vertebra. It appears heterogeneously hyperintense on T2Wl and hypointense on T1Wl. The involved vertebra and adjacent collection is seen to extend into the spinal canal causing its stenosis and compresses the thecal sac and spinal cord.

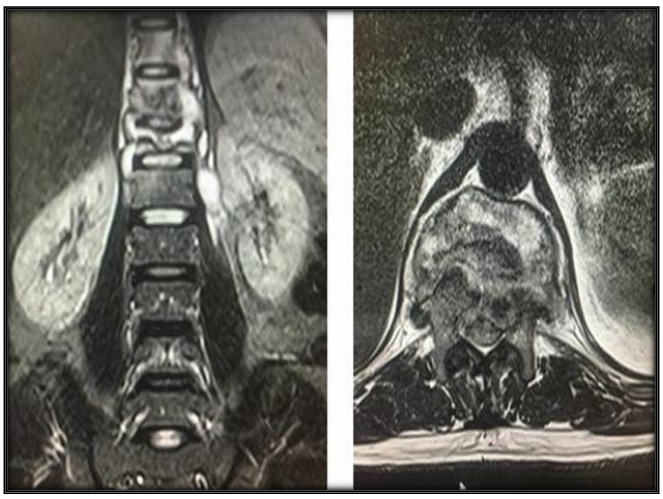

Figure 7: coronal section of the same patient (as in figure 6) showing heterogeneously T2 hyperintense collection in the paraspinal location surrounding the D11 and D12 vertebra and adjacent collection extending into the spinal canal causing its stenosis and compressing the thecal sac and spinal cord. The compressed spinal canal shows T2 hyperintensity and likely represents cord edema.

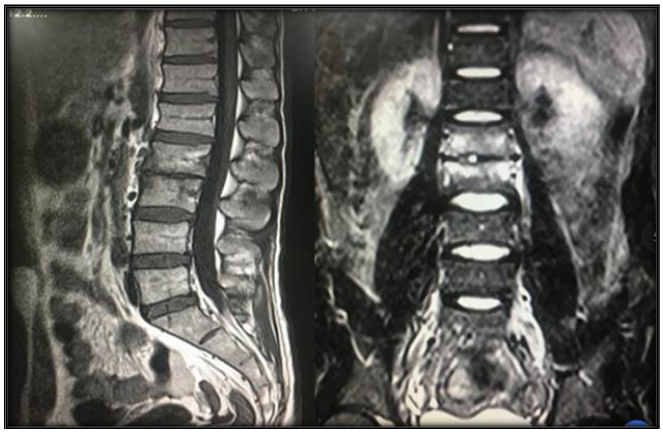

Figure 8: A 27 year male presented with chronic back pain, mild fever and weight loss. MRI shows altered signal intensity at contagious end plates of L2 and L3 vertebral bodies mostly at peridiscal margins with reduced intervening L2-L3 interverbal disc height. Posterior appendages are intact. No spine canal encroachment is seen.

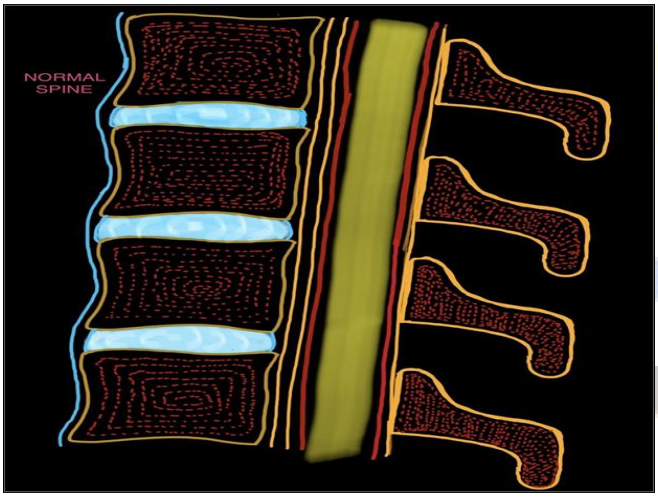

Figure 9: Illustrative diagram depicting the normal spine

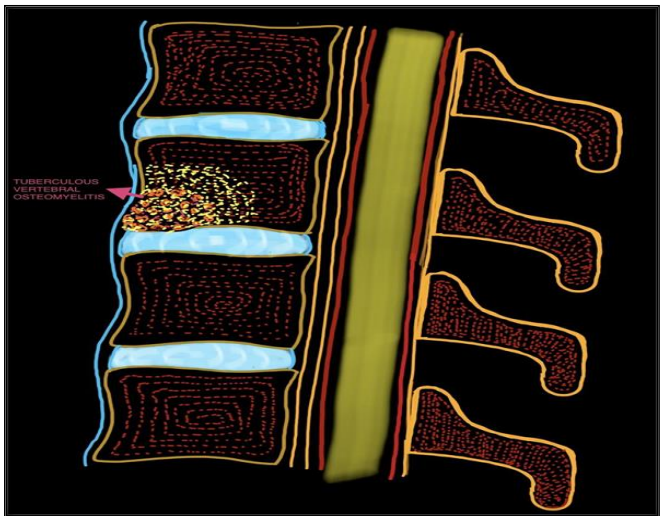

Figure 10: Initial vertebral body involvement may be indistinguishable from early pyogenic spondylitis; however, the disc space is uniquely spared in the early and intermediate phases of tubercular spondylitis in contrast to pyogenic bacterial infections.

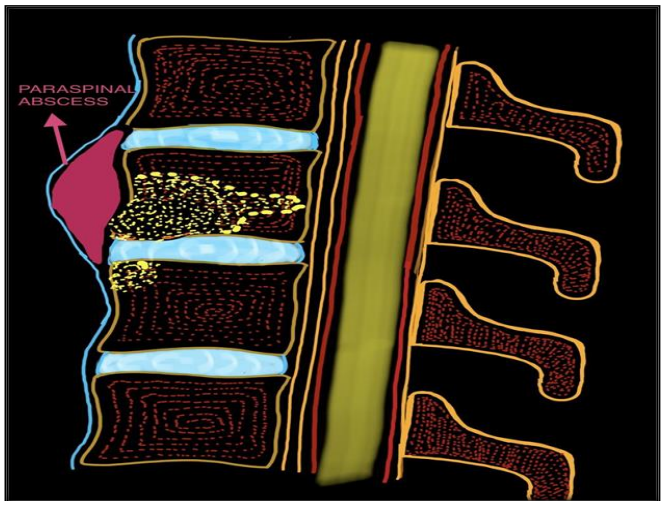

Figure 11: bone destruction with peripherally enhancing intra osseous and thin-walled sub ligmentous para spinal abscesses demonstrating limited surrounding inflammatory phlegmonous changes is commonly encountered prior to involvement of the disc space.

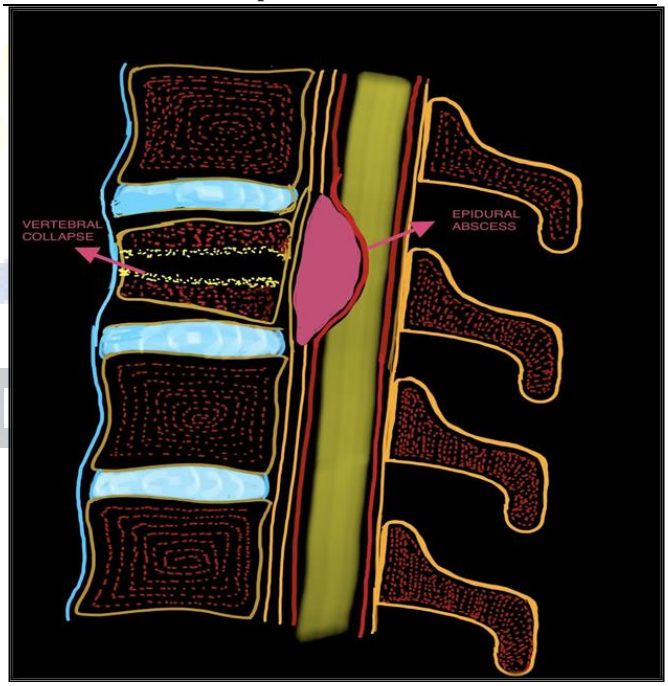

Figure 12: Epidural abscess. Vertebral collapse – which is a common late stage complication.

Discussion

Tubercular spondylitis can occur at any age. The mean age was found to be 30.5 years from an age range of 11 to 70 years in our study.

In our study, we found that males were predominantly affected (60.4 %), similar to other studies done by S Khalequzzaman et al, in which involvement of the spine was more common in males than females.[15]

In our study backache was the most common presenting complaint, in 58 (92%), which was followed by low grade fever in 49(77.7%). Similar to the studies done by Sajidansari et al.[4]

In our study the most common feature on MRI was found to be bone marrow edema and end plate irregularities which were observed in all patients i.e., 63 patients (100%) and followed by vertebral collapse.

Similar results were noted in a study by Khalequzzaman et al in Bangladesh where signal change was noted in 42 patients (100 %), destruction and collapse in 37 patients (88.1 %).[17,18,19,20,21,22]

Dorso-lumbar vertebrae are involved most commonly in our study as was also noted in various other studies such as Bajwa G.R.[5,16]

Involvement of a single vertebral body was not seen in any patient.

In our study paradiscal variant was most common.

Posterior spinal involvement was noted in 9 (14.2%) patients in our study.[23,24]

However, none of the patients had isolated posterior spinal involvement.

MRI is very useful while evaluating involvement, extent and response to therapy in cases of isolated tuberculosis of posterior elements as concluded by the study by Narlawar RS et al.[3]

Spinal canal compression exceeding 20%, resulted in neurological symptoms, which in our study, was 28 patients.

Sajid Ansari et al in their study found similar findings and concluded that decompressive surgery with anti-tubercular chemotherapy was the best mode of treatment in such cases.[4]

A study conducted by Khalid et al in evaluating the role of magnetic resonance imaging in tubercular spondylitis in correlation with the clinical severity of disease, concluded that MRI plays an important role in diagnosing spinal infections accurately even in the early stages of disease. MRI is a non-invasive modality and superior to plain radiographs and Computed Tomography (CT) as demonstration of soft tissue anatomy and pathology can be made clearly on MRI.[8,20,22]

Harada.Y.et al retrospectively compared imaging findings in 10 spinal tuberculosis patients with 13 patients having pyogenic spondylitis on magnetic resonance imaging and concluded that it plays a crucial role in differentiating Pott's spine from pyogenic spondylitis.[9,25]

Newer advances in imaging of spinal tuberculosis incorporate the use of diffusion-weighted magnetic resonance imaging (DW-MRI) and apparent diffusion coefficient (ADC) values which help in differentiating spinal tuberculosis from other lesions of similar morphology.

Conclusion

Spinal tuberculosis is best assessed on magnetic resonance imaging as it provides significant information, which ranges from edema involving vertebral bodies and intervertebral disc to epidural collections/ abscesses and vertebral body destruction leading to spinal cord compression. Knowing the spectrum of various magnetic resonance imaging features in tubercular spondylitis is of utmost importance, as morbidity caused by this disease can be limited by making early diagnosis and planning the appropriate further management.

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