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Original Research Article

Role of magnetic resonance imaging in differentiating tuberculous spondylitis from pyogenic spondylitis in a TB endemic area

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ABSTRACT

Background: Infectious spondylitis is an infection by a specific organism of one or more components of spine, namely the vertebra, intervertebral discs, paraspinal soft tissues, and epidural space. Magnetic resonance imaging (MRI) of the spine is gold standard in imaging to assess anatomical abnormalities of the spine and surrounding structures.
Methods: This cross-sectional observational study was conducted in the Department of Radiology Narayan Medical College and Hospital Sasaram, Bihar (India), where tuberculosis is endemic from July 2022 to September 2023. It included 40 patients, purposively sampled, adhering to strict inclusion and exclusion criteria. Sensitivity, specificity and accuracy of MRI in discriminating tuberculous spondylitis from pyogenic spondylitis were compared against histopathological diagnosis and differences in MRI findings between these conditions were obtained.
Results: In this study, 93% patients with tuberculous spondylitis had an enhanced signal with well-defined margins. Meanwhile, pyogenic spondylitis provided an ill-defined margins in 72.7% patients. Most of the patients 82.7% with tuberculous spondylitis showed thin and smooth wall paravertebral abscesses, while pyogenic spondylitis showed an irregular and thick wall paravertebral abscesses in 45% patients. A total of 72.4% patients with tuberculous spondylitis indicated involvement of ≥3 vertebral bodies. 100% patients with pyogenic spondylitis showed an abnormal contrast enhancement of the intervertebral discs. It was identified that tuberculous spondylitis had sensitivity, specificity, and accuracy values of 100%, 84.6%, and 95.2% respectively. For pyogenic spondylitis, the corresponding values were 84.6%, 96.6%, and 93%.
Conclusions: MRI was accurate for differentiation of tuberculous spondylitis from pyogenic spondylitis. A well-defined paraspinal abnormal signal, a thin and smooth abscess wall, subligamentous spread to three or more vertebral levels, and less likely involvement of intervertebral discs were more suggestive of tuberculous spondylitis than pyogenic spondylitis.

Keywords: Tuberculous, Pyogenic, Spondylitis, Histopathological, Paraspinal, Intraosseous, Abscess

INTRODUCTION

Infectious spondylitis is defined as an infection by a specific organism of one or more components of the spine, namely the vertebra, intervertebral discs, paraspinal soft tissues, and epidural space.[1] Though it is difficult to differentiate tuberculous spondylitis from pyogenic spondylitis but it is important as proper treatment of the different types of spondylitis can reduce the rate of disability and functional impairment.[2,3] However, it is difficult to differentiate these two types radiographically.[1,2]

Magnetic resonance imaging (MRI) of the spine is the gold standard to assess anatomical abnormalities of the spine and surrounding structures, determine the level of spinal damage, and follow-up a disease. MRI can give us a better chance to see a change in medullary bones. MRI is also

expected to show early disc abnormalities and changes in bone marrow (a component of fat and water) in the case of infection.[4,5]

The only early symptom of spondylitis is non-specific back pain, which makes it difficult to diagnose early. MRI can help in early diagnosis of the disease and hence reduce rate of disability.[6] A previous study states that a 1.5 Tesla MRI had a sensitivity of 96% and a specificity of 94% in the diagnosis of spondylitis.[7] Tuberculous spondylitis is common in developing countries. It is noted that tuberculous spondylitis occurs in 1% of all tuberculous infection patients, and 25%–60% of bone and joint infections are caused by tuberculosis.[7–10] Research by Lee stated that pyogenic spondylitis is a rare disease with a prevalence of ~0.15%–3% in osteomyelitis cases.[10] It is important to differentiate between tuberculous and pyogenic spondylitis as early diagnosis and correct management can improve functional outcomes in patients with infectious spondylitis.[3]

The purpose of this study was to determine the sensitivity, specificity and accuracy of MRI in discriminating tuberculous spondylitis from pyogenic spondylitis and to seek differences in MRI findings between these conditions in Bihar (India), where tuberculosis is endemic.

METHODS

This cross-sectional observational study was conducted in the Department of Radiology Narayan Medical College and Hospital Sasaram, Bihar (India), where tuberculosis is endemic over a period of 15 months from July 2022 to September 2023. The study cohort included 40 patients aged between 10 and 80 years, patients were purposively sampled, adhering to strict inclusion and exclusion criteria. The study was approved from institution ethics committee and informed written consent was taken from patients before initiation of MRI scan.

Sample size

A total of 40 patients were included in the study who were adhering to strict inclusion and exclusion criteria after obtaining the written consent from the patients.

Inclusion criteria

Patients with clinically suspected spondylitis aged between 10-80 years referred from the Department of Neurology, Orthopaedics and Surgery.

Exclusion criteria

Patients with prior history of trauma or surgery. Patients with any metallic implants and patients less then 10 years and more than 80 years of age.

MRI spine analysis

MRIs of patients were done in patients who presented with signs and symptoms of spondylitis, referred from the department of Neurology, Orthopaedics and Surgery. MRI was performed on 1.5 Tesla Magnetom Essenza, Siemens system, standardized multiplanar and multiecho sequence with IV MR contrast media administration.

Axial and sagittal T1-weighted MR images (TR range/TE range, 350– 650/11–30) and fast spin-echo or turbo spin-echo T2-weighted images (3,000–4,000/76–108) were obtained. In addition, axial and sagittal fat-sup- pressed T1-weighted images (350–800/11–30) were obtained. Presence or absence of individual imaging criteria, an overall assessment of the type of spondylitis was made. The margin of paraspinal abnormal signal, the appearance of the abscess walls, the extent of subligamentous spread, involvement of multiple vertebral bodies, entire body involvement, and the signal intensity of involved vertebral bodies were evaluated. The abscess wall was assessed on the basis of the contrast-enhanced images.

The signal intensity in the marrow of abnormal vertebrae was considered hypointense, isointense, or hyperintense by comparison with the signal intensity of normal vertebrae in the same patient on T1- and T2-weighted images.

The data was analysed using appropriate SPSS software (Trial version-21). The findings were correlated with histopathological report for final diagnosis.

RESULTS

During the study period, 40 patients were diagnosed with infectious spondylitis (pyogenic spondylitis in 11 patients and tuberculous spondylitis in 29 patients).

In the pyogenic spondylitis group, 6 patients (66.7%) were male with a mean age of 46.3 years (range 10 to 80 years). The mean age of tuberculous spondylitis patients was 38.6 years (range 10-80 years) and 17 (70.8%) were male (Table 1 and 2).

Table 1: Gender distribution among the study subjects.

Gender	Tuberculous group	Pyogenic group
Male	17	6
Female	12	5
Total	29	11

Table 2: Age distribution among study subjects.

Age group (in years)	Tuberculous group (n=29)	Pyogenic group (n=11)
10-20	2	1
21-30	5	1
31-40	4	2
41-50	5	2
51-60	6	2
61-70	4	3
71-80	3	-

Table 3: Distribution of lesions in tuberculous and pyogenic spondylitis.

Level of vertebral involvement	Tuberculous group (%)	Pyogenic group (%)
Cervical spine	7 (24.1)	1 (9)
Thoracic spine	12 (41.3)	3 (27.2)
Lumbar spine	9 (31)	5 (45.4)
Sacral spine	1 (3.4)	2 (18.1)

Table 4: Number of vertebrae involved in tuberculous and pyogenic spondylitis.

Number of vertebrae involved	Tuberculous group (%)	Pyogenic group (%)
1	2 (6.8)	2 (18.1)
2	6 (20)	5 (45.4)
3	12 (41.3)	3 (27)
4 or more	9 (31)	1 (9)

Tuberculous spondylitis was more common in thoracic spine (41.3%) followed by lumbar spine (31%) and had three or more vertebral spine involvements (41%) more commonly. When compared with pyogenic spondylitis showed predilection for lumbar spine (45.4%) (Tables 3 and 4).

Table 5: MRI features of tuberculous and pyogenic spondylitis.

MRI Findings	Tuberculous group (n=29) (%)	Pyogenic group (n=11) (%)
Well-defined paraspinal abnormal signal	27 (93)	3 (27.2)
Ill-defined paraspinal abnormal signal	1 (3.4)	8 (72.7)
Thin and smooth abscess walls	24 (82.7)	1 (9)
Presence of paraspinal or intraosseous abscess	25 (86.2)	6 (54.5)
Subligamentous spreading >3 levels	21 (72.4)	4 (36.3)
Thoracic spine involvement	12 (41.3)	3 (27.2)
Abnormal contrast enhancement of intervertebral disc	7 (24.1)	11 (100)
Abnormal soft tissue contrast enhancement around the facet joints	9 (31)	7 (63.3)

MRI features of tuberculous and pyogenic spondylitis

The signal abnormality of enhanced MRI in the vertebral body and surrounding soft tissue was different between tuberculous and pyogenic spondylitis. 27 (93%) patients with tuberculous spondylitis had an enhanced signal with well-defined margins and 2 (6.8%) patients with ill-defined margins. Meanwhile, pyogenic spondylitis provided an enhanced signal with well-defined margin in 3 (27.2%) patients and ill-defined margins in 8 (72.7%) patients. 25 (86.2%) patients with tuberculous spondylitis showed presence of paraspinal or intraosseous abscess as compared to 6 (54.5 %) patients with pyogenic spondylitis (Table 5).

Paravertebral abscess enhancement was divided into two types, the first was thin and smooth walls and the second irregular and thick walls. Most of the patients 24 (82.7%) with tuberculous spondylitis showed thin and smooth wall paravertebral abscesses, while pyogenic spondylitis showed irregular and thick wall paravertebral abscesses in 5 (45 %) patients.

A total of 21 (72.4%) patients with tuberculous spondylitis indicated the involvement of ≥3 vertebral bodies, whereas 4 (36.3%) patients with pyogenic spondylitis showed involvement of ≥3 vertebral bodies.

Overall patients (100%) with pyogenic spondylitis showed an abnormal contrast enhancement on the intervertebral discs. In contrast, 7(24.1%) patients with tuberculous spondylitis showed an abnormal contrast enhancement on it.

Abnormal soft tissue contrast enhancement around the facet joints was more common in pyogenic spondylitis seen in 7 patients (63.3%) compared with tuberculous spondylitis in 9 patients (31%).

Table 6: Major differences between tuberculous vs pyogenic spondylitis according to this study.

Tuberculous spondylitis	Pyogenic spondylitis
Well-defined paraspinal abnormal signal	Ill-defined paraspinal abnormal signal
Presence of paraspinal or intraosseous abscess	Less likely
Thin and smooth abscess walls	Thick and irregular abscess walls
Mostly involves multiple vertebral level involvement (>3 levels)	Involves 2 or more than 2 vertebral levels
Thoracic spine predilection	Lumbar spine predilection
Intervertebral disc involvement is less likely	Frequent involvement of intervertebral disc

As per our study the major differences between tuberculous and pyogenic spondylitis are as follows (Table 6).

Table 7: Diagnostic values of tuberculous vs pyogenic spondylitis according to this study.

Type of spondylitis	Sensitivity	Specificity	Accuracy	PPV	NPV
Tuberculous spondylitis	100%	84.6%	95.2%	93.3%	100%
Pyogenic spondylitis	84.6%	96.6%	93%	91.6%	93.5%

In our study it was identified that tuberculous spondylitis had sensitivity, specificity, and accuracy values of 100%, 84.6%, and 95.2% respectively. For pyogenic spondylitis, the corresponding values were 84.6%, 96.6%, and 93% (Table 7).

DISCUSSION

The symptoms and clinical findings in patients with spinal infection are often non-specific and vary depending on the site, extent, and severity of the pathological process.[11]

In tuberculous spondylitis, the infection usually begins within the anterior sub-chondral part of the vertebral body and may spread through the disc space into the adjacent vertebrae. Secondary subligamentous spreading in tuberculous spondylitis is frequent, usually beneath the anterior longitudinal ligament. However, spreading beneath the posterior longitudinal ligament can also be found. Epidural extension may cause a neural compromise.[12]

Due to lack of proteolytic enzymes in *Mycobacterium* spp, relative preservation of the intervertebral disc is proposed. In pyogenic spondylitis, the common organisms are *Staphylococcus aureus*, *Enterobacter*, *Salmonella*, *Klebsiella*, *Pseudomonas* and *Serratia* spp. These organisms can produce enzymes, including hyaluronidase, resulting in lysis of the intervertebral disc.[13]

Tuberculosis of the spine accounts for more than 50% of musculoskeletal tuberculosis. The importance of early diagnosis and prompt treatment of infectious spondylitis based on a specific diagnosis cannot be overemphasized in minimizing the residual spinal deformity or permanent neurologic deficit. Differentiation between tuberculous and pyogenic spondylitis is difficult clinically and radiographically. MRI has been reported to be useful in the early detection of spondylitis.[14]

In our study, tuberculous spondylitis involved more often the thoracic spine (41.3%) followed by lumbar spine (31%), similar findings were demonstrated by Hidalgo and Lee.[10,15] Most common locations of pyogenic spondylitis were lumbar spine (45.4%) and thoracic (27.2%) spine.

The abnormalities of MRI signal post-contrast in the vertebral corpus and surrounding soft tissue differ between tuberculous and pyogenic spondylitis. In this study, 27 (93%) patients with tuberculous spondylitis had an enhanced signal with well-defined margins and 2 (6.8%) patients with ill-defined margins. Meanwhile, pyogenic spondylitis provided an enhanced signal with well-defined margins in 3 (27.2%) patients and ill-defined margins in 8 patients (72.7%). Hyaluronidase, a proteolytic enzyme which is predominantly found in bacterial infections, causes lysis and destruction of parts of the vertebrae worse than infection by Mycobacterium tuberculosis.[3]

Tuberculous spondylitis accounts for 25 (86.2%) patients with paraspinal or intraosseous abscess as compared to 6 (54.5 %) patients who had pyogenic spondylitis.

Contrast enhancement of a paravertebral abscess is divided into enhancement with smooth thin walls and irregular thick walls. Tuberculous spondylitis gives an overview in the form of enhancement in abscess with smooth and thin walls, in as many as 24 patients (82.7%), and abscess with thick walls, irregularly for 1 patient (4%) (Figure 1).

Pyogenic spondylitis gives an overview in the form of enhancement in abscess with thin walls, regularly for 1 patient (9%) and the thick walls, irregularly for 5 patients (45 %). This is consistent with a previous study conducted by Harada et al, who states that tuberculous spondylitis can be distinguished from pyogenic spondylitis, by the thickness and irregularities of wall of paravertebral abscesses, as tuberculous spondylitis shows paravertebral abscesses with regular thin walls while pyogenic spondylitis shows paravertebral abscesses with thick, irregular walls (Figure 2).[7]

A total of 21 patients (72.4%) with tuberculous spondylitis showed involvement of ≥3 vertebral bodies and 8 patients (27.5%) showed the involvement of ≤2 corpus vertebrae, on the contrary, as many as 7 patients (63.6%) with pyogenic spondylitis showed involvement of ≤2 corpus vertebral bodies. The presence of proteolytic enzymes in bacterial infection will cause damage to vertebral discs and other parts of the vertebrae. Such damage causes more severe clinical manifestation than tuberculous spondylitis. Thus, pyogenic spondylitis is often detected earlier, with a fewer number of involved corpus vertebrae than tuberculous spondylitis.[7-9,14]

Overall patients with pyogenic spondylitis showed an abnormal contrast enhancement in intervertebral discs, in 11 patients (100%). In contrast, 76% of patients with tuberculous spondylitis did not show enhancement of the intervertebral discs. Lack of proteolytic enzymes in Mycobacterium infection compared with other bacterial infections is the reason for the exclusion of the discs.

In our study it was identified that tuberculous spondylitis had sensitivity, specificity, and accuracy values of 100%, 84.6%, and 95.2% respectively. For pyogenic spondylitis, the corresponding values were 84.6%, 96.6%, and 93%.

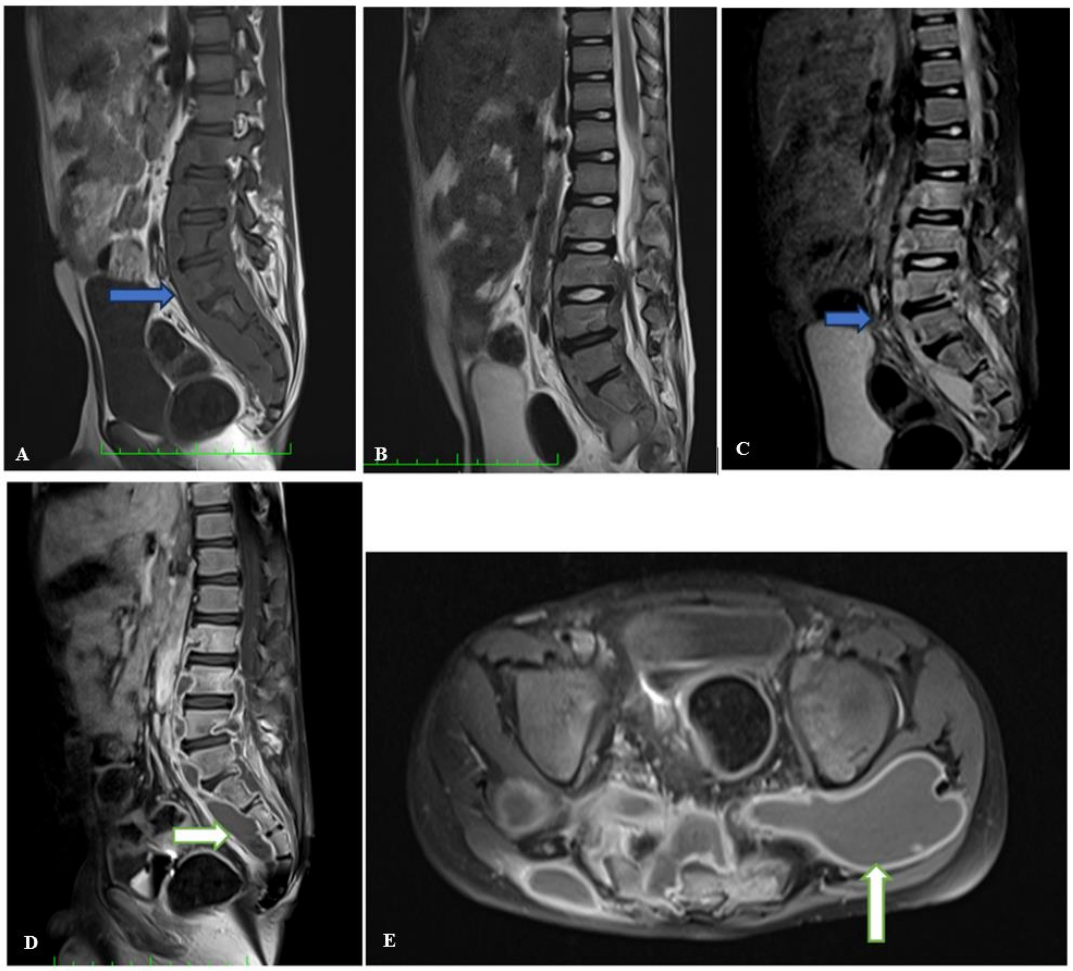

Figure 1: Tuberculous spondylitis in a 45 year old male (A) T1-weighted sagittal image (B) T2-weighted sagittal image (C) Sagittal STIR image show heterogeneous abnormal signal intensity from L2-S2 vertebrae; also note large epidural extension and subligamentous spreading from L2 – S3 level (blue arrow). Preservation discs is seen. (D) Fat-suppressed CE T1-weighted sagittal image shows multiple thin and smooth walled abscesses with epidural extensions extending from L2-S3 vertebral levels. (E) Fat-suppressed CE T1-weighted axial image) shows multiple thin and smooth walled abscesses with epidural and paraspinal muscular extension (white arrows).

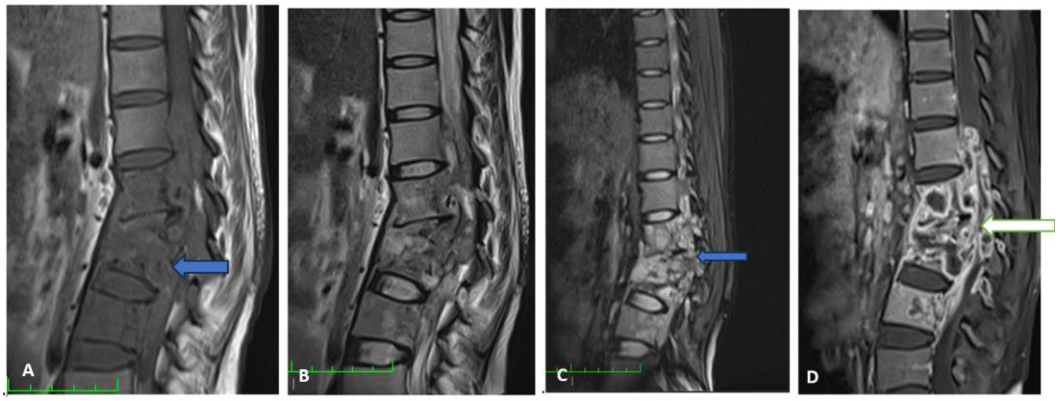

Figure 2: Pyogenic spondylitis in a 20 year old girl. (A) T1-weighted sagittal image (B) T2-weighted sagittal image (C) Sagittal STIR image show L1 vertebral and D12-L1 intervertebral disc destruction with heterogeneous abnormal signal intensity from D12-L2 vertebrae; also note epidural extension and subligamentous spreading from D11 – L2 level (blue arrow).(D) Fat-sup-pressed CE T1-weighted sagittal image shows multiple thick, irregular wall intraosseous abscesses with epidural and subligamentous spread along posterior longitudinal ligament from D11-L2 level (white arrow).

Limitations

The study was conducted in a single hospital with a small sample size, also, patients included in this study belonged mostly to the same region. So, the results may not represent the whole community.

CONCLUSION

In conclusion, MRI was accurate for differentiation of tuberculous spondylitis from pyogenic spondylitis. A well-defined paraspinal abnormal signal, thin and smooth abscess wall, paraspinal intraosseous signal, subligamentous spread to three or more vertebral levels, Thoracic spine predilection and less likely involvement of intervertebral discs were more suggestive of tuberculous spondylitis than pyogenic spondylitis.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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