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Original Research Article

MRI and Microbiological Correlation in Pyogenic Versus Tubercular Spondylodiscitis: A Retrospective Observational Study

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Conflict of interest: Nil

Abstract

Background: Spondylodiscitis is an important cause of persistent back pain and spinal morbidity. Pyogenic infection and spinal tuberculosis may have overlapping clinical and magnetic resonance imaging (MRI) manifestations. This study evaluated MRI characteristics of pyogenic and tubercular spondylodiscitis and their correlation with microbiological and histopathological findings.

Methods: A retrospective observational study was conducted at Patna Medical College Hospital, Patna. Records of 100 patients with infective spondylodiscitis evaluated from January 2024 to January 2026 were reviewed. MRI findings, bacterial culture, tuberculosis molecular testing and histopathology were recorded. Patients were categorized into pyogenic and tubercular groups according to the final etiological diagnosis.

Results: Of 100 patients, 58 (58.0%) had pyogenic and 42 (42.0%) had tubercular spondylodiscitis. Disc involvement was more frequent in pyogenic disease (91.4% vs 73.8%; p=0.021), whereas paravertebral abscess (19.0% vs 59.5%; p<0.001), epidural extension (17.2% vs 38.1%; p=0.022), vertebral collapse (12.1% vs 33.3%; p=0.012), subligamentous spread (8.6% vs 40.5%; p<0.001) and skip lesions (3.4% vs 19.0%; p=0.015) were more frequent in tubercular disease. Staphylococcus aureus was the predominant isolate among pyogenic cases.

Conclusion: MRI provides useful etiological clues and defines the extent of spinal infection, but imaging overlap remains substantial. Correlation with microbiological and histopathological findings is important for definitive etiological classification.

Keywords: Spondylodiscitis; Spinal Tuberculosis; Pyogenic Spondylodiscitis; MRI; Microbiology; CBNAAT; Vertebral Osteomyelitis.

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Introduction

Spondylodiscitis is an infectious process involving the vertebral endplates and intervertebral disc, with possible extension into paravertebral and epidural spaces. Delayed diagnosis may result in vertebral destruction, deformity, neurological impairment and prolonged morbidity [1,2].

Pyogenic infection and spinal tuberculosis are major causes of infective spondylodiscitis. Staphylococcus aureus is the leading pathogen in native vertebral osteomyelitis, while tuberculosis remains an important cause of spinal infection in high-burden settings [3–7]. Clinical manifestations are often nonspecific and include persistent back pain, fever, constitutional symptoms and neurological deficits. Fever may be absent, limiting clinical differentiation between etiologies [1,3,4]. MRI is the preferred imaging modality for suspected spinal infection because it demonstrates vertebral marrow, endplate, disc, paravertebral and epidural abnormalities with high soft-tissue contrast [1–3,8].

Certain imaging patterns may suggest etiology. Pyogenic infection commonly causes early disc-space involvement and adjacent endplate destruction, whereas spinal tuberculosis may show extensive vertebral involvement, paravertebral collections, subligamentous spread, collapse and noncontiguous lesions. However, these findings

overlap and are not individually diagnostic [6–10]. Microbiological confirmation is therefore important. Bacterial culture can identify the causative organism in pyogenic disease, while molecular tuberculosis tests and histopathology can support the diagnosis of spinal tuberculosis [3,11,12].

This study compared MRI characteristics of pyogenic and tubercular spondylodiscitis and evaluated their correlation with available microbiological and histopathological evidence.

Aim: To evaluate MRI characteristics of pyogenic and tubercular spondylodiscitis and assess their correlation with microbiological findings.

Objectives

1. To describe the demographic and clinical profile of patients with infective spondylodiscitis.
2. To compare MRI findings between pyogenic and tubercular spondylodiscitis.
3. To determine the frequency of vertebral, discal, paravertebral and epidural involvement.
4. To describe the microbiological profile of pyogenic disease and diagnostic evidence supporting tuberculosis.
5. To evaluate associations between MRI findings and final etiological diagnosis.

Materials and Methods

Study Design and Setting: This retrospective observational study was conducted at Patna Medical College Hospital, Patna, and Bihar, India.

Study Period: Patient records for admissions from January 1, 2024 through January 31, 2026 were reviewed.

Sample Size: A total of 100 eligible patient records meeting the predefined eligibility criteria were included in the final analysis. Because this was a retrospective record-based study, all eligible records available during the study period were considered; no separate prospective recruitment was performed.

Eligibility: Adults with MRI findings compatible with infective spondylodiscitis and adequate diagnostic documentation were included.

Patients with noninfectious degenerative/v inflammatory disease, trauma explaining the imaging findings, inadequate records, or indeterminate postoperative abnormalities were excluded.

Data Collection: Demographic, clinical, MRI and microbiological data were extracted from hospital medical records/MRD documentation using a structured data-extraction approach. The analysis was based on available records; variables not documented in the source record were treated as unavailable rather than imputed.

MRI Assessment: MRI was assessed for vertebral marrow signal alteration, endplate destruction, disc involvement, paravertebral collection/abscess, epidural extension, vertebral collapse, subligamentous spread and skip lesions.

Microbiological Assessment: Available bacterial culture and antimicrobial susceptibility results were recorded from the medical record. For suspected tuberculosis, CBNAAT and histopathological findings were recorded when available. Culture-negative pyogenic cases were retained in the etiological analysis when the final diagnosis was otherwise supported by the documented diagnostic assessment.

Final Diagnosis: Pyogenic disease was assigned when the documented final diagnosis supported a bacterial etiology. Tubercular disease was assigned when CBNAAT/molecular evidence, compatible histopathology, or documented clinical-radiological evidence with supportive treatment response supported spinal tuberculosis. Diagnostic evidence categories in the tuberculosis analysis were not mutually exclusive.

Statistical Analysis: Continuous variables were summarized as mean ± standard deviation, and categorical variables as frequencies and percentages. Between-group categorical comparisons were performed using the chi-square test or Fisher's exact test, as appropriate.

Continuous variables were compared using an appropriate parametric or nonparametric test according to distributional characteristics. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Results

Patient Characteristics: The study included 100 patients, of whom 58 (58.0%) had pyogenic and 42 (42.0%) had tubercular spondylodiscitis. The etiological distribution is shown in Figure 1. Baseline characteristics are summarized in Table 1.

Table 1: Demographic and clinical characteristics.

Variable	Pyogenic (n=58)	Tubercular (n=42)	p-value
Mean age, years	52.1 ± 14.6	43.7 ± 15.2	0.006
Male	37 (63.8%)	24 (57.1%)	0.509
Female	21 (36.2%)	18 (42.9%)	—
Back pain	55 (94.8%)	40 (95.2%)	0.927
Fever	25 (43.1%)	17 (40.5%)	0.796
Neurological symptoms	12 (20.7%)	13 (31.0%)	0.242

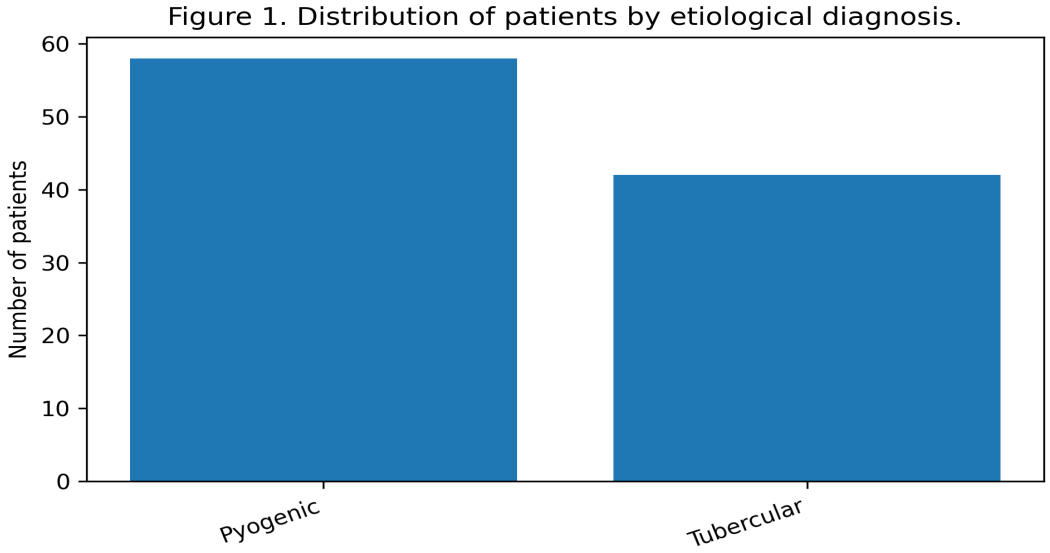


Figure 1: Distribution of patients by etiological diagnosis.

Spinal level distribution: Lumbar involvement was the most common site in both groups. The anatomical distribution is shown in Table 2.

Table 2: Anatomical distribution of spinal involvement.

Site	Pyogenic n (%)	Tubercular n (%)
Cervical	4 (6.9)	3 (7.1)
Thoracic	12 (20.7)	11 (26.2)
Thoracolumbar	10 (17.2)	8 (19.0)
Lumbar	27 (46.6)	17 (40.5)
Lumbosacral	5 (8.6)	3 (7.1)

MRI findings: Table 3 summarizes the MRI findings, and Figure 2 provides a graphical comparison. Disc involvement was significantly more frequent in pyogenic disease, whereas paravertebral abscess, epidural extension, vertebral collapse, subligamentous spread and skip lesions were significantly more frequent in tubercular disease.

Table 3: MRI characteristics in pyogenic and tubercular spondylodiscitis. *Paravertebral collection and paravertebral abscess were recorded as separate MRI descriptors in the source dataset; the definitions used in the original radiology documentation should be retained for auditability.

MRI feature	Pyogenic (n=58)	Tubercular (n=42)	p-value
Disc involvement	53 (91.4%)	31 (73.8%)	0.021
Endplate destruction	49 (84.5%)	30 (71.4%)	0.116
Vertebral marrow edema	56 (96.6%)	40 (95.2%)	0.722
Paravertebral collection*	16 (27.6%)	30 (71.4%)	<0.001
Paravertebral abscess	11 (19.0%)	25 (59.5%)	<0.001
Epidural extension	10 (17.2%)	16 (38.1%)	0.022
Vertebral collapse	7 (12.1%)	14 (33.3%)	0.012
Subligamentous spread	5 (8.6%)	17 (40.5%)	<0.001
Skip lesions	2 (3.4%)	8 (19.0%)	0.015

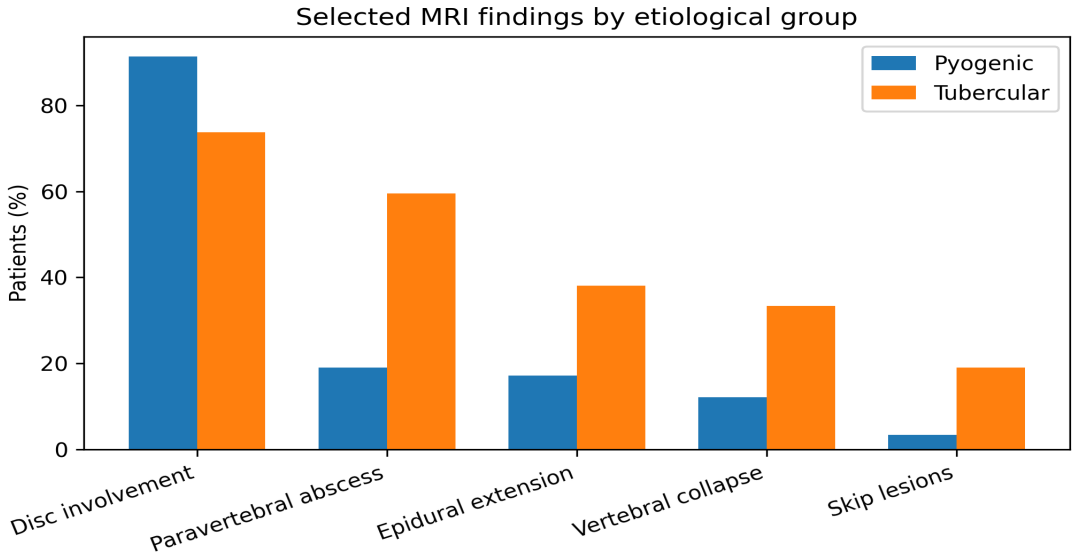


Figure 2: Selected MRI findings by etiological group.

Microbiological findings: The microbiological profile recorded among the pyogenic cases is presented in Table 4 and Figure 3. Staphylococcus aureus was the most frequent identified organism. Twenty-five pyogenic cases (43.1%) had no organism isolated.

Table 4: Microbiological profile of pyogenic spondylodiscitis.

Organism	Number (%)
Staphylococcus aureus	17 (29.3)
Coagulase-negative Staphylococcus spp.	5 (8.6)
Escherichia coli	4 (6.9)
Klebsiella spp.	3 (5.2)
Pseudomonas spp.	2 (3.4)
Other organisms	2 (3.4)
No organism isolated	25 (43.1)

Figure 3. Microbiological profile of pyogenic spondylodiscitis.

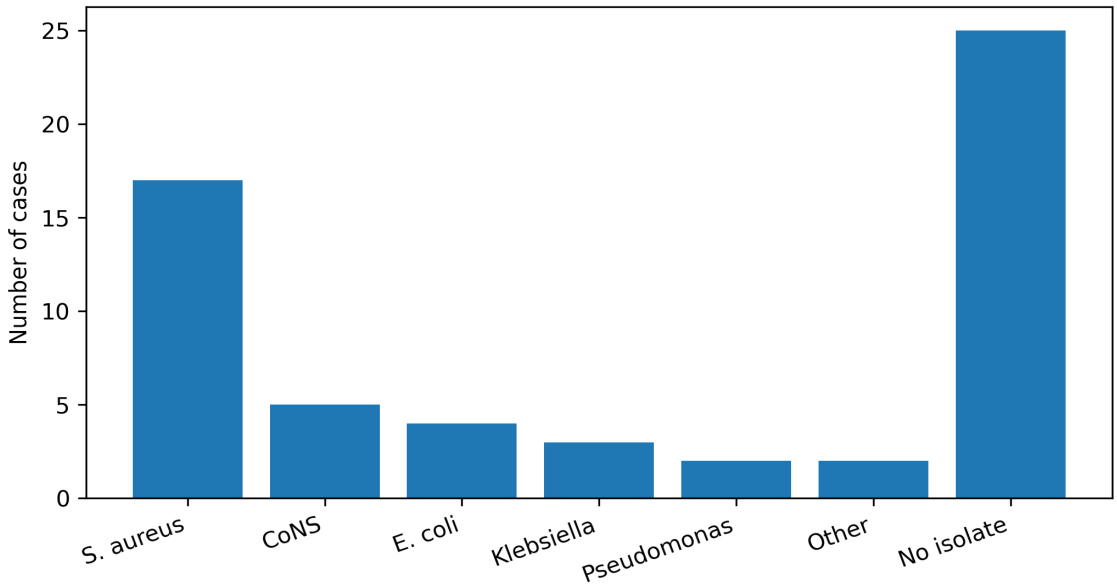


Figure 3: Microbiological profile of pyogenic spondylodiscitis.

Tuberculosis diagnostic evidence: Available diagnostic evidence supporting tubercular disease is summarized in Table 5 and Figure 4. These evidence categories are not mutually exclusive; therefore, their percentages are not expected to sum to 100%.

Table 5: Diagnostic evidence supporting tubercular spondylodiscitis (categories are non-mutually exclusive).

Diagnostic evidence	Number (%)
CBNAAT positive	27 (64.3)
Histopathology supportive	31 (73.8)
Both microbiological and histopathological support	21 (50.0)
Clinical-radiological diagnosis with supportive response	8 (19.0)

Figure 4. Diagnostic evidence supporting tubercular spondylodiscitis.

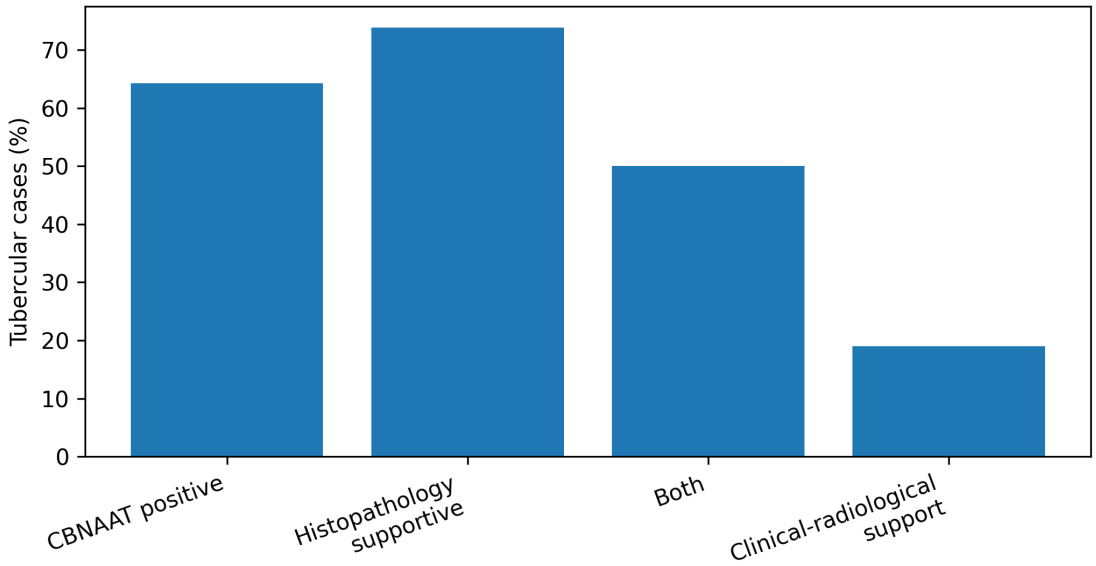


Figure 4: Diagnostic evidence supporting tubercular spondylodiscitis.

MRI–etiological correlation: Table 6 summarizes MRI characteristics associated with the final etiological classification. Paravertebral abscess, subligamentous spread, epidural extension, skip lesions and vertebral collapse were significantly more common in tubercular disease.

Table 6: MRI–etiological correlation.

MRI characteristic	Pyogenic n (%)	Tubercular n (%)	p-value
Predominant disc-space involvement	53 (91.4)	31 (73.8)	0.021
Paravertebral abscess	11 (19.0)	25 (59.5)	<0.001
Epidural extension	10 (17.2)	16 (38.1)	0.022
Subligamentous spread	5 (8.6)	17 (40.5)	<0.001
Skip lesions	2 (3.4)	8 (19.0)	0.015
Vertebral collapse	7 (12.1)	14 (33.3)	0.012

Discussion

The present study demonstrates that MRI can provide useful clues for differentiating pyogenic and tubercular spondylodiscitis, while microbiological and histopathological investigations remain important for etiological confirmation [1–4].

Pyogenic infection represented 58% of the cohort and tuberculosis 42%. The substantial tuberculosis burden is clinically relevant in settings where spinal tuberculosis remains an important manifestation of extrapulmonary disease [6,7,12]. Back pain was almost universal in both groups, whereas fever occurred in fewer than half of patients. This emphasizes the nonspecific clinical presentation of vertebral infection and the importance of imaging when suspicion persists [1,3,4]. The lumbar spine was the most frequently affected region in both groups, consistent with the recognized distribution of native vertebral osteomyelitis and spinal tuberculosis [1,6,7]. Disc involvement was more common in pyogenic disease. Bacterial infection frequently spreads from

the vertebral endplate into the adjacent disc, producing contiguous vertebral-disc involvement [1–3,8]. Paravertebral abscess and subligamentous spread were markedly more common in tubercular disease. These are recognized imaging patterns of spinal tuberculosis and may reflect extension along longitudinal spinal ligaments and formation of relatively large collections [6–10].

Skip lesions were uncommon but significantly more frequent in the tubercular group. Noncontiguous involvement can therefore increase suspicion for tuberculosis, although its absence does not exclude the disease [6–10].

Vertebral collapse was also more frequent in tubercular disease. Progressive osseous destruction may result in collapse and deformity, particularly in delayed or advanced disease [6,7].

Epidural extension occurred in both groups and was more common in tuberculosis. Because epidural disease can cause neural compression, its detection on MRI is clinically important [1,2,6].

Staphylococcus aureus was the predominant organism among pyogenic cases, in keeping with established descriptions of native vertebral osteomyelitis [3–5]. The relatively high culture-negative proportion also illustrates the limitations of microbiological yield in vertebral infection [3,4].

CBNAAT and histopathology provided important diagnostic evidence in tubercular cases. Molecular testing can provide rapid evidence of Mycobacterium tuberculosis and may provide drug-resistance information, while tissue histopathology offers complementary diagnostic support [11,12].

Overall, MRI and microbiological testing should be regarded as complementary. MRI defines anatomical extent and suggests etiology, while microbiological and histopathological investigations provide evidence required for targeted treatment [1,3,11].

Limitations include the retrospective design, potential missing data, nonuniform availability of contrast-enhanced MRI and variation in microbiological sampling. The single-center setting may limit external validity.

Conclusion

MRI provides valuable anatomical and etiological clues in infective spondylodiscitis. Predominant disc involvement favored pyogenic disease, whereas paravertebral abscess, subligamentous spread, epidural extension, vertebral collapse and skip lesions were more strongly associated with tubercular disease. Because imaging findings overlap, MRI should be integrated with bacterial culture, tuberculosis molecular testing and histopathology whenever feasible.

Declarations

Ethics Approval: This retrospective observational study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Patna Medical College Hospital, Patna, and Bihar, India. As the study involved retrospective review of anonymized medical records, the Institutional Ethics Committee granted a waiver of individual informed consent, where applicable.

Data Availability: The study data are available from the corresponding author/institution subject to institutional policy, ethical approval, and applicable data-protection restrictions.

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