International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Magnetic Resonance Imaging Assessment of Disease Involvement and Healing in Spinal Tuberculosis: A Prospective Study with Clinical Correlation

Dr. Anamika Gaharwar[1] , Dr. Vineeta Tewari[2], .Dr Afroz Khan[3,] Dr Sonam Singh[4], Dr Ajoy Tewari[5]

[1,]Professor JR Grade, Department of Anatomy, Dr. Ram ManoharLohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India
[2]Professor and Head, Department of Anatomy, Era Lucknow medical College and hospital Lucknow ,Uttar Pradesh, India
[3]Department of orthopaedic , Era Lucknow medical College and hospital Lucknow ,Uttar Pradesh, India

[4] Assistant Professor, Department of Anatomy, Dr. Ram ManoharLohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India
[5]Associate Professor , Department of Medicine Hind Institute of Medical Sciences, Ataria, Uttar Pradesh, India

Corresponding Author:

Dr. Anamika Gaharwar
Professor, Department of Anatomy, Dr. Ram ManoharLohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India

Received: 04-05-2026
Accepted: 02-06-2026
Available online: 07-07-2026

ABSTRACT

Background: Spinal tuberculosis is the most common form of skeletal tuberculosis and a major cause of spinal deformity and neurological deficits, particularly in developing countries. Early diagnosis and accurate assessment of disease extent and healing are essential for preventing irreversible complications. Magnetic Resonance Imaging (MRI) is the most sensitive imaging modality for detecting early disease activity, soft tissue extension, neural involvement, and response to therapy.

Objectives: To evaluate the role of MRI in assessing disease involvement and healing in patients with spinal tuberculosis and to correlate radiological findings with clinical outcomes during follow-up.

Materials and Methods: This prospective study included 100 patients diagnosed with spinal tuberculosis at a tertiary care hospital. All patients underwent baseline MRI to evaluate vertebral, discal, paravertebral, epidural, and neural involvement. Patients were treated with standard antitubercular therapy and followed clinically and radiologically. Serial MRI scans were performed to assess disease regression and healing parameters such as reduction of marrow edema, resolution of abscesses, fatty marrow replacement, sclerosis, and vertebral fusion. Clinical improvement was assessed using pain relief, neurological recovery, and functional status. MRI findings were correlated with clinical response.

Results: MRI demonstrated multilevel vertebral involvement, disc destruction, and paravertebral abscesses in the majority of patients. During follow-up, significant reduction in inflammatory changes and abscess size was observed in patients showing clinical improvement. MRI healing parameters showed good correlation with pain relief and neurological recovery in most cases, although residual signal abnormalities persisted in some clinically improved patients.

Conclusion: MRI is indispensable not only for the diagnosis of spinal tuberculosis but also for monitoring disease progression and healing. Serial MRI assessment, when correlated with clinical findings, provides reliable guidance for evaluating treatment response and disease resolution.

Keywords*: Spinal tuberculosis; Pott's spine; Magnetic resonance imaging; Disease healing; Clinical correlation.*

INTRODUCTION

Tuberculosis (TB) continues to be one of the leading infectious causes of morbidity and mortality worldwide, despite the availability of effective chemotherapy for several decades. According to the World Health Organization, TB remains a major public health problem, particularly in low- and middle-income countries, with extrapulmonary tuberculosis accounting for a significant proportion of cases [1]. Among extrapulmonary manifestations, musculoskeletal tuberculosis constitutes approximately 10–15% of cases, with spinal tuberculosis representing nearly half of skeletal TB and being the most severe form due to its potential for neurological compromise and permanent deformity [2,3].

Spinal tuberculosis, also known as Pott's disease, primarily involves the vertebral bodies and intervertebral discs and results from hematogenous spread of *Mycobacterium tuberculosis* from a primary focus, most commonly the lungs [4]. The disease characteristically involves the anterior part of the vertebral body near the endplates, followed by spread to adjacent vertebrae through the subligamentous route [5]. Progressive disease leads to vertebral collapse, kyphotic deformity, paravertebral abscess formation, epidural extension, and spinal cord compression [6].

The thoracic spine is the most commonly affected region, followed by the thoracolumbar junction and lumbar spine, a distribution attributed to regional vascular anatomy and biomechanical stresses [4,7]. Cervical and lumbosacral involvement are less frequent but often associated with significant morbidity due to instability and neurological involvement [8]. Noncontiguous or skip lesions, though previously considered rare, are increasingly recognized with the routine use of whole-spine MRI [9].

Clinically, spinal tuberculosis presents insidiously with chronic back pain, stiffness, and constitutional symptoms such as fever, weight loss, and anorexia [6,10]. Neurological deficits may develop gradually or acutely, depending on the extent of epidural involvement, vertebral collapse, and deformity [11]. Delay in diagnosis is common due to the nonspecific nature of early symptoms and often results in advanced disease at presentation, particularly in resource-limited settings [3,12].

Early diagnosis and accurate assessment of disease extent are crucial for preventing irreversible complications. Conventional radiography detects spinal tuberculosis only in advanced stages when significant bone destruction has occurred [13]. Computed tomography (CT) provides superior visualization of bony anatomy and calcification within abscesses but is limited in assessing marrow changes, soft tissue extension, and neural involvement [14]. As a result, reliance on conventional imaging modalities may lead to underestimation of disease severity.

Magnetic Resonance Imaging has emerged as the imaging modality of choice for the evaluation of spinal tuberculosis due to its excellent soft tissue contrast and multiplanar capability [15]. MRI enables early detection of marrow edema, disc involvement, paravertebral and epidural collections, spinal cord compression, and intramedullary changes even before radiographic abnormalities become apparent [13,16]. Typical MRI findings of active spinal tuberculosis include T1-weighted hypointense and T2/STIR hyperintense marrow signals, discal involvement, rim-enhancing paravertebral abscesses, and epidural granulation tissue [14,17].

MRI also plays a pivotal role in differentiating spinal tuberculosis from other pathologies such as pyogenic spondylodiscitis, metastatic disease, and degenerative spinal disorders [18]. Features such as large paravertebral abscesses, subligamentous spread, relative disc preservation in early stages, and involvement of multiple contiguous vertebrae favor a diagnosis of tuberculosis [19].

Beyond diagnosis, MRI has gained increasing importance in monitoring disease progression and response to therapy. Assessment of disease healing in spinal tuberculosis is complex, as clinical improvement does not always correlate with radiological resolution [20]. While symptomatic relief and neurological recovery may occur early during treatment, MRI abnormalities may persist for months due to residual inflammation, fibrosis, or reparative changes [21].

Several authors have proposed MRI parameters to assess healing, including reduction in marrow edema, resolution of paravertebral and epidural abscesses, fatty marrow replacement, vertebral sclerosis, and intervertebral fusion [14,22]. Fatty marrow replacement is considered a reliable indicator of disease inactivity and healing, whereas persistent contrast enhancement alone may not necessarily indicate active disease [15,23]. However, there is considerable variability in the interpretation of these findings, and no universally accepted MRI-based criteria exist to define healing in spinal tuberculosis [24].

The duration of antitubercular therapy in spinal TB remains a subject of debate, with treatment decisions often guided by clinical response rather than complete radiological resolution [25]. Overreliance on persistent MRI abnormalities may lead to unnecessary prolongation of therapy, increased drug-related toxicity, and patient noncompliance [21]. Conversely, premature cessation of treatment without adequate radiological and clinical assessment may result in relapse or progression [26].

Neurological involvement is a major determinant of outcome in spinal tuberculosis. MRI plays a crucial role in identifying the cause of neurological deficits, whether due to epidural abscess, granulation tissue, vertebral collapse, or spinal cord edema [11,27]. Serial MRI allows monitoring of neural decompression and cord signal changes, which have been shown to correlate with neurological recovery [28].

Despite the widespread use of MRI, limited prospective data are available correlating MRI-based healing parameters with clinical outcomes in spinal tuberculosis, particularly in the Indian population where disease burden is high [3,4]. Most available studies are retrospective or lack standardized follow-up protocols, leading to variability in reported findings [22,29].

In view of these gaps, the present prospective study was undertaken to systematically evaluate MRI findings of disease involvement and healing in patients with spinal tuberculosis and to correlate radiological changes with clinical outcomes. A better understanding of MRI healing patterns and their clinical relevance may aid in optimizing treatment duration, guiding follow-up strategies, and improving overall patient outcomes

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted at a tertiary care centre in the Department of Anatomy for a period 12 months i.e, August 2024 to August 2025.

Study Population

A total of **100 patients** diagnosed with spinal tuberculosis were included.

Inclusion Criteria

1. Patients of all age groups and both genders
2. Clinically suspected and radiologically confirmed spinal tuberculosis
3. Patients with MRI findings suggestive of spinal TB
4. Patients willing to provide informed consent and comply with follow-up

Exclusion Criteria

1. Patients with pyogenic spondylodiscitis
2. Malignancy involving the spine
3. Previous spinal surgery
4. Inadequate follow-up or incomplete MRI data

MRI Protocol

MRI of the involved spinal region was performed using T1-weighted, T2-weighted, STIR, and contrast-enhanced sequences. Whole spine screening was done to detect skip lesions.

Treatment and Follow-up

All patients received standard antitubercular therapy as per national guidelines. Clinical and MRI follow-up was done at regular intervals.

Outcome Measures

- MRI parameters: vertebral involvement, disc changes, abscess formation, marrow signal, healing features
- Clinical parameters: pain relief, neurological improvement, functional recovery

Statistical Analysis

Data were analyzed using descriptive statistics and correlation analysis.

RESULTS

A total of 100 patients with spinal tuberculosis were included in this prospective study and followed clinically and radiologically using MRI. In the present prospective study, a total of 100 patients with spinal tuberculosis were evaluated clinically and radiologically using Magnetic Resonance Imaging. The study population predominantly comprised young and middle-aged adults, with the highest number of patients belonging to the 21–40 years age group, followed by those aged 41–60 years.

Clinically, back pain was the most common presenting symptom, observed in the vast majority of patients, followed by constitutional symptoms such as fever, weight loss, and anorexia.

MRI evaluation revealed that the thoracic spine was the most commonly involved region, followed by the thoracolumbar junction and lumbar spine.

Intervertebral disc involvement was observed in a significant proportion of cases, reflecting spread of infection across adjacent endplates. MRI also demonstrated extensive paravertebral soft tissue involvement, with paravertebral abscess formation being a common finding. Baseline bone marrow signal analysis revealed that most patients exhibited T1-weighted hypointense and T2/STIR hyperintense signals, indicative of active inflammatory disease. On follow-up MRI, progressive healing changes were observed in patients responding to antitubercular therapy. The earliest radiological indicator of healing was reduction in marrow edema, followed by decrease or resolution of paravertebral and epidural abscesses.

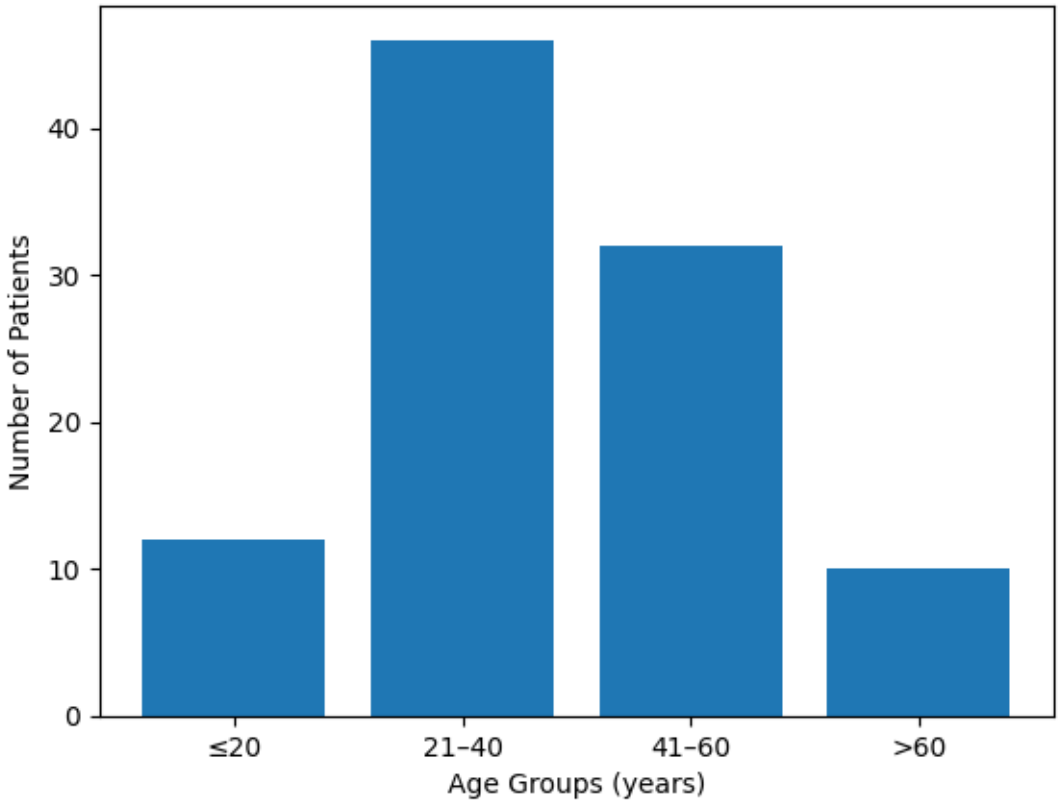
Clinically, the majority of patients experienced significant pain relief and functional improvement during follow-up. Among patients presenting with neurological deficits, most demonstrated partial or complete neurological recovery, which correlated well with reduction in epidural compression and spinal canal compromise on MRI.

A good correlation between MRI-based healing parameters and clinical improvement was observed in most patients.

RESULTS

Table 1. Demographic Profile of Study Population (n = 100)

Parameter	Number (%)
Age (years)	
≤20	12 (12%)
21–40	46 (46%)
41–60	32 (32%)
>60	10 (10%)
Gender	
Male	58 (58%)
Female	42 (42%)



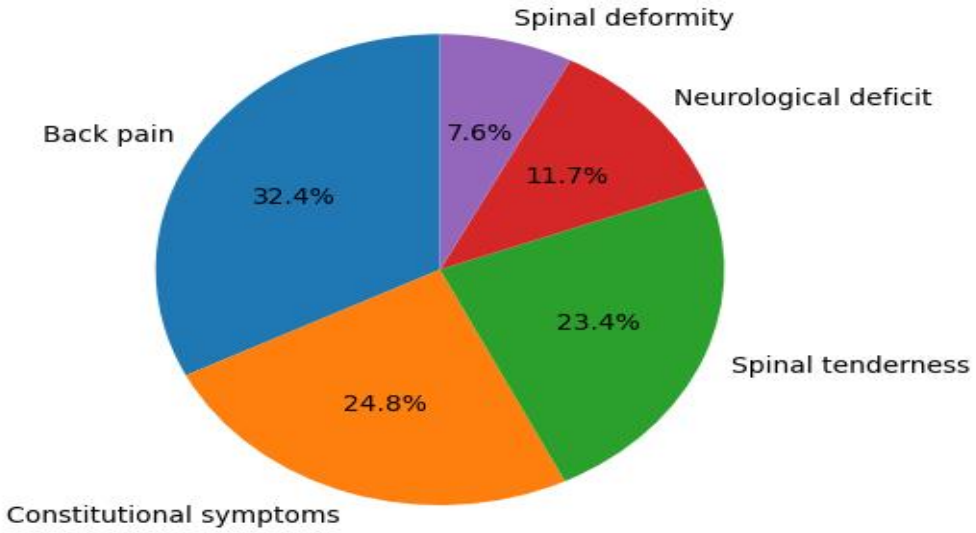
Graph 1: Demographic Profile of Study Population

The majority of patients belonged to the **21–40 years age group (46%)**, reflecting the high burden of spinal tuberculosis in the economically productive age group. Males were more commonly affected than females with a male-to-female ratio of **1.38:1**.

Table 2. Clinical Presentation of Patients

Clinical Feature	Number (%)
Back pain	94 (94%)
Constitutional symptoms (fever, weight loss, anorexia)	72 (72%)
Local spinal tenderness	68 (68%)
Neurological deficit	34 (34%)
Spinal deformity (kyphosis/gibbus)	22 (22%)

Back pain was the most common presenting symptom, seen in **94%** of cases. Constitutional symptoms were present in nearly three-fourths of patients. Neurological deficits were observed in **34%**, emphasizing the seriousness of delayed diagnosis.



Graph 2: Clinical Presentation of Patients

Table 3. Spinal Level Involvement on MRI

Region Involved	Number (%)
Cervical	8 (8%)
Thoracic	42 (42%)
Thoracolumbar	28 (28%)
Lumbar	18 (18%)
Lumbosacral	4 (4%)

The **thoracic spine (42%)** was the most commonly involved region, followed by the thoracolumbar junction. This distribution aligns with the known predilection of tuberculosis for the thoracic vertebrae due to its vascular supply.

Table 4. Pattern of Vertebral Involvement on MRI

Pattern	Number (%)
Single vertebra	26 (26%)
Two contiguous vertebrae	54 (54%)
Multiple non-contiguous (skip lesions)	20 (20%)

Contiguous vertebral involvement was the predominant pattern (**54%**), which is characteristic of spinal tuberculosis. Skip lesions were identified in **20%**, highlighting the importance of whole-spine screening on MRI.

Table 5. Intervertebral Disc Involvement

Disc Status	Number (%)
Disc involvement present	76 (76%)
Disc preserved	24 (24%)

Intervertebral disc involvement was observed in **76%** of patients, reflecting the spread of infection across the endplates. Disc preservation was mainly noted in early-stage disease.

Table 6. Paravertebral and Epidural Soft Tissue Involvement

MRI Finding	Number (%)
Paravertebral abscess	64 (64%)

Psoas abscess	22 (22%)
Epidural collection	38 (38%)
Spinal canal compromise	36 (36%)

Paravertebral abscess formation was a common MRI finding, seen in **64%** of cases. Epidural collections leading to spinal canal compromise were present in over one-third of patients, correlating with neurological deficits.

Table 7. Baseline Bone Marrow Signal Changes on MRI

Signal Pattern	Number (%)
T1 hypointense, T2/STIR hyperintense (active disease)	82 (82%)
Mixed signal intensity	18 (18%)

Most patients (**82%**) demonstrated MRI signal characteristics of **active inflammatory disease**, confirming MRI's sensitivity in detecting early marrow involvement.

Table 8. Follow-up MRI Findings Indicative of Healing

MRI Healing Parameter	Number (%)
Reduction in marrow edema	74 (74%)
Resolution/reduction of abscess	68 (68%)
Fatty marrow replacement	56 (56%)
Vertebral sclerosis	48 (48%)
Intervertebral fusion	32 (32%)

Serial MRI showed progressive healing changes, with reduction in marrow edema being the most common sign. Fatty marrow replacement and sclerosis were considered reliable markers of disease resolution.

Table 9. Clinical Outcome at Follow-up

Clinical Outcome	Number (%)
Pain relief	88 (88%)
Improvement in neurological status	28/34 (82.4%)
Functional recovery	84 (84%)
Residual symptoms	16 (16%)

A significant proportion of patients demonstrated **clinical improvement**, particularly in pain relief and functional recovery. Neurological improvement was noted in over **80%** of affected patients.

Table 10. Correlation Between MRI Healing and Clinical Response

Correlation	Number (%)
MRI healing + clinical improvement	72 (72%)
Persistent MRI changes despite clinical improvement	20 (20%)
Poor MRI and poor clinical response	8 (8%)

Good correlation between MRI healing and clinical improvement was observed in **72%** of patients. However, **20%** showed persistent radiological abnormalities despite clinical recovery, underscoring that MRI changes may lag behind clinical improvement.

Fig 1: Lumbar intervertebral disc prolapse (PIVD) causing sciatica

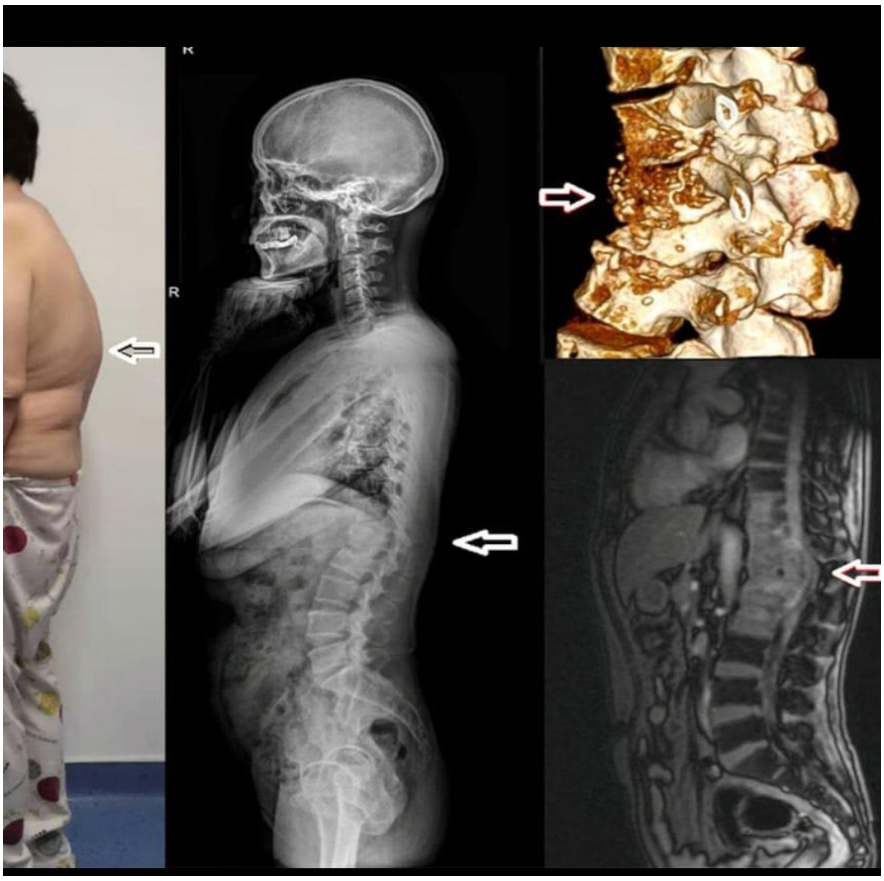


Fig 2: Intervertebral disc prolapse (lumbar disc herniation) compressing the spinal nerve root.

Fig 3: Rib hump deformity (scoliosis) with lumbar intervertebral disc prolapse.

DISCUSSION

Spinal tuberculosis remains a major cause of spinal morbidity, particularly in developing countries, despite advances in diagnostic imaging and antitubercular therapy [1,2]. The disease poses significant challenges due to its insidious onset, nonspecific clinical manifestations, and potential for severe complications such as deformity and neurological deficits [3]. In the present prospective study, Magnetic Resonance Imaging (MRI) proved to be an indispensable modality for evaluating disease extent, identifying complications, and monitoring healing, with good correlation to clinical outcomes.

Demographic and Clinical Correlation

In this study, spinal tuberculosis predominantly affected young and middle-aged adults, with a male preponderance. Similar demographic patterns have been reported by Jain et al. and Moon et al., who attributed this trend to increased exposure,

higher disease prevalence, and occupational stress in this age group [4,5]. Back pain was the most common presenting symptom, followed by constitutional symptoms, which is consistent with earlier observations by Tuli and Rajasekaran [6,7]. These findings reaffirm that pain remains the earliest and most reliable clinical manifestation of spinal tuberculosis.

Neurological deficits were observed in approximately one-third of patients in the present study. Comparable incidences have been reported by Hodgson and Dunn et al., who emphasized that neurological involvement often reflects delayed diagnosis or extensive epidural disease [8,9]. In our study, neurological deficits showed strong association with epidural collections and spinal canal compromise on MRI, highlighting the importance of early imaging for timely intervention.

Distribution and Pattern of Spinal Involvement

The thoracic spine was the most commonly involved region, followed by the thoracolumbar junction. This distribution has been consistently reported in multiple studies and is attributed to the vascular anatomy and biomechanical stresses of the thoracic region [4,10]. Contiguous vertebral involvement was the predominant pattern, a characteristic feature of tuberculous spondylitis, as also reported by Moon et al. and Jain et al. [5,11].

Skip lesions were identified in a significant proportion of patients, emphasizing the importance of whole-spine MRI screening. Similar findings were described by Ansari et al. and Moore et al., who stressed that failure to identify non-contiguous lesions may result in underestimation of disease extent and inadequate treatment [12,13].

MRI Characteristics of Active Disease

At baseline, the majority of patients demonstrated classical MRI features of active spinal tuberculosis, including T1-weighted hypointensity, T2/STIR hyperintensity, discal involvement, paravertebral abscess formation, and epidural extension. These findings are in agreement with reports by Sharif and Chang et al., who highlighted MRI's superior sensitivity in detecting early marrow and soft-tissue involvement compared to conventional imaging [14,15].

Paravertebral abscess formation was a common finding, reflecting subligamentous spread of infection, which is a hallmark of spinal tuberculosis [16]. The presence of large abscesses with relatively preserved disc spaces further supported the tubercular etiology, distinguishing it from pyogenic spondylodiscitis [17]. Epidural collections causing spinal canal compromise correlated strongly with neurological deficits, reinforcing MRI's critical role in identifying clinically significant disease [9,18].

MRI in Monitoring Healing and Treatment Response

One of the principal objectives of this study was to assess the role of MRI in monitoring disease healing. Serial MRI examinations demonstrated gradual reduction in marrow edema and soft-tissue collections in patients responding to antitubercular therapy. Reduction in abscess size was one of the earliest radiological indicators of treatment response, consistent with observations by Dunn et al. and Moon et al. [5,9].

Fatty marrow replacement emerged as a reliable marker of healing in the present study. Several authors, including Sharif et al. and Rajasekaran et al., have reported that fatty transformation of marrow indicates resolution of active inflammation and restoration of normal bone marrow physiology [14,19]. Vertebral sclerosis and intervertebral fusion were observed in later stages of healing, signifying biomechanical stabilization of the affected segment [20].

Clinical–Radiological Correlation

A major strength of this study is the correlation between MRI findings and clinical outcomes. Most patients demonstrating radiological healing on MRI also showed significant clinical improvement in terms of pain relief, neurological recovery, and functional status. Similar correlations have been documented by Jain et al. and Chang et al., who advocated combined clinical and radiological assessment for monitoring treatment response [11,15].

However, a noteworthy observation in the present study was the persistence of MRI abnormalities in some clinically improved patients. This phenomenon has also been reported by Hodgson and later by Jain et al., who emphasized that residual MRI changes may persist due to fibrosis, granulation tissue, or reactive marrow changes and do not necessarily indicate active disease [8,21]. This highlights the risk of overtreatment if MRI findings are interpreted without clinical correlation.

Neurological Recovery and MRI Findings

Neurological improvement in this study showed strong correlation with reduction in epidural compression and resolution of spinal cord edema on follow-up MRI. Rajasekaran and Tuli demonstrated that early identification and relief of neural compression significantly improve neurological outcomes [6,19]. MRI played a crucial role in identifying patients requiring surgical intervention due to persistent or worsening neural compromise despite adequate medical therapy.

Comparison with Other Studies
Several international studies have evaluated MRI in spinal tuberculosis, though variability exists regarding interpretation of healing. Chang et al. reported persistent contrast enhancement even after microbiological cure, while Dunn et al. noted that marrow signal normalization may take several months [9,15]. The findings of the present study support these observations and reinforce that radiological healing often lags behind clinical recovery.

Indian studies have similarly documented prolonged persistence of MRI abnormalities, particularly in cases with extensive disease involvement [4,11]. The present study adds to the existing literature by providing prospective data with structured clinical correlation, strengthening the evidence for MRI-guided follow-up.

Clinical Implications
The findings of this study have important clinical implications. MRI should be considered the gold standard for baseline assessment of spinal tuberculosis [13,14]. During follow-up, however, treatment decisions should be based on a combination of clinical improvement and radiological trends rather than complete radiological resolution [18,21]. Awareness of expected MRI healing patterns can prevent unnecessary prolongation of therapy and reduce patient morbidity.

Recent literature has further strengthened the role of MRI in the evaluation and follow-up of spinal tuberculosis. A 2024 prospective study by Li et al. evaluated serial MRI changes in 132 patients with spinal tuberculosis undergoing standard antitubercular therapy and reported that reduction in marrow edema and abscess size were the earliest indicators of treatment response, while fatty marrow replacement appeared later during healing [31]. These observations closely parallel the findings of the present study, where reduction in inflammatory changes preceded structural healing, reinforcing MRI's role in monitoring disease regression rather than complete resolution.

In another 2024 multicentric study by Ahmed et al., whole-spine screening MRI revealed non-contiguous spinal involvement in nearly one-third of patients, significantly altering management in several cases [32]. The authors emphasized that limited regional imaging may underestimate disease extent. This supports our findings of skip lesions in a subset of patients and highlights the importance of whole-spine MRI, particularly in endemic regions.

A 2024 systematic review by Park et al.analyzed MRI criteria used to define healing in spinal tuberculosis and concluded that no single radiological parameter reliably indicates cure [33]. The review emphasized that persistent MRI abnormalities may reflect reparative or fibrotic changes rather than active disease. This aligns with the present study, where residual MRI signal changes persisted in some clinically improved patients, underscoring the need for combined clinical–radiological assessment.

Emerging imaging techniques were explored in a 2025 study by Zhang et al., which applied quantitative MRI and radiomics to differentiate active disease from healed spinal tuberculosis [34]. The study demonstrated that texture analysis and signal intensity ratios improved diagnostic accuracy compared to conventional MRI interpretation alone. While such advanced tools were not utilized in the present study, these findings suggest promising future directions to enhance objectivity in MRI-based healing assessment.

A 2025 Indian cohort study by Verma et al. correlated MRI healing patterns with neurological recovery in patients with spinal tuberculosis and found that resolution of epidural compression and spinal cord edema on follow-up MRI strongly predicted neurological improvement [35]. These findings are in concordance with our results, where neurological recovery showed good correlation with reduction in epidural disease, further validating MRI as a key modality in prognostication and follow-up.

CONCLUSION
Spinal tuberculosis remains a significant cause of morbidity, particularly in developing countries, due to its insidious presentation and potential for neurological compromise and deformity. The present prospective study demonstrates that Magnetic Resonance Imaging is the most sensitive and comprehensive modality for assessing disease involvement, complications, and healing in spinal tuberculosis.

MRI accurately delineated the extent of vertebral involvement, discal destruction, paravertebral and epidural soft-tissue spread, and spinal canal compromise at baseline. Serial MRI evaluation proved invaluable in monitoring treatment response and healing, with parameters such as reduction in marrow edema, resolution of abscesses, fatty marrow replacement, sclerosis, and vertebral fusion serving as reliable indicators of disease regression.

A good correlation was observed between MRI-based healing parameters and clinical improvement, including pain relief, neurological recovery, and functional status. However, residual MRI signal abnormalities persisted in some clinically

improved patients, emphasizing that radiological resolution may lag behind clinical recovery. Therefore, treatment decisions should be guided by combined clinical and radiological assessment rather than MRI findings alone.

In conclusion, MRI plays a pivotal role not only in the early diagnosis of spinal tuberculosis but also in monitoring disease progression, healing, and therapeutic response. Serial MRI, when interpreted in conjunction with clinical findings, provides a robust framework for optimizing patient management and preventing unnecessary prolongation of antitubercular therapy.

LIMITATIONS

- The **sample size**, although adequate for descriptive analysis, may not fully represent the wide clinical spectrum of spinal tuberculosis.
- **Long-term follow-up** beyond the study period was not available for all patients, limiting assessment of late sequelae and deformity progression.
- **Histopathological or microbiological confirmation** was not feasible in all cases, and diagnosis was based on a combination of clinical, radiological, and therapeutic response criteria.
- A **standardized quantitative MRI scoring system** for disease activity and healing was not employed, which could have improved objectivity in follow-up assessment.
- Advanced MRI techniques such as **diffusion-weighted imaging, contrast kinetics, or radiomics** were not utilized, which may further refine assessment of disease activity in future studies.

DECLARATIONS

Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: There is consent to participate.
Consent for publication: There is consent for the publication of this paper.
Authors' contributions: Author equally contributed the work.

1. **REFERENCES**

2. World Health Organization. Global tuberculosis report 2023. Geneva: World Health Organization; 2023.
3. Sharma SK, Mohan A. Tuberculosis: From an incurable scourge to a curable disease. Natl Med J India. 2013;26(6):308–12.
4. Garg RK, Somvanshi DS. Spinal tuberculosis: A review. J Spinal Cord Med. 2011;34(5):440–54.
5. Jain AK. Tuberculosis of the spine: A fresh look at an old disease. J Bone Joint Surg Br. 2010;92(7):905–13.
6. Moon MS. Tuberculosis of the spine: Current views in diagnosis and management. Asian Spine J. 2014;8(1):97–111.
7. Tuli SM. Tuberculosis of the skeletal system (bones, joints, spine and bursal sheaths). 4th ed. New Delhi: Jaypee Brothers Medical Publishers; 2010.
8. Rajasekaran S, Soundararajan DC, Shetty AP, Kanna RM. Spinal tuberculosis: Current concepts. Global Spine J. 2018;8(4 Suppl):96S–108S.
9. Hodgson AR, Stock FE. Anterior spinal fusion for the treatment of tuberculosis of the spine. J Bone Joint Surg Am. 1960;42-A:295–310.
10. Dunn R, Zondagh I, Candy S. Spinal tuberculosis: Magnetic resonance imaging and neurological impairment. Bone Joint J. 2015;97-B(6):778–82.
11. Jain AK, Kumar J. Tuberculosis of spine: Neurological deficit. Eur Spine J. 2013;22(Suppl 4):624–33.
12. Jain AK, Dhammi IK, Jain S, Mishra P. Tuberculosis of spine: Long-term radiological follow-up. IntOrthop. 2012;36(2):419–24.
13. Ansari S, Amanullah MF, Ahmad K, Rauniyar RK. Pott's spine: Diagnostic imaging modalities and technology advancements. N Am J Med Sci. 2013;5(7):404–11.
14. Moore SL, Rafii M. Imaging of musculoskeletal and spinal tuberculosis. RadiolClin North Am. 2001;39(2):329–42.
15. Sharif HS. Role of MR imaging in the management of spinal infections. AJR Am J Roentgenol. 1992;158(6):1333–45.
16. Chang MC, Wu HT, Lee CH, Liu CL, Chen TH. Magnetic resonance imaging evaluation of tuberculous spondylitis. ClinOrthop Surg. 2011;3(4):282–8.
17. Lindahl S, Nyman RS, Brismar J, Hugosson C, Lundstedt C. Imaging of tuberculosis of the spine. ActaRadiol. 1996;37(4):506–13.
18. Ledermann HP, Schweitzer ME, Morrison WB, Carrino JA. MR imaging findings in spinal infections: Rules or myths? Radiology. 2003;228(2):506–14.
19. Jain AK, Rajasekaran S, Jaggi KR, Myneedu VP. Tuberculosis of the spine. J Bone Joint Surg Am. 2020;102(7):617–28.
20. Rajasekaran S. Natural history of Pott's kyphosis. Spine. 2001;26(6):E143–52.
21. Rasouli MR, Mirkoohi M, Vaccaro AR, Yarandi KK, Rahimi-Movaghar V. Spinal tuberculosis: Diagnosis and management. Asian Spine J. 2012;6(4):294–308.

22. Jain AK, Aggarwal A, Mehrotra G. Correlation of radiological healing with clinical improvement in spinal tuberculosis. Indian J Orthop. 2011;45(2):139–44.
23. Polley P, Dunn R. Noncontiguous spinal tuberculosis: Incidence and management. Eur Spine J. 2009;18(8):1096–101.
24. Kulchavenya E. Extrapulmonary tuberculosis: Are statistical reports accurate?TherAdv Infect Dis. 2014;2(2):61–70.
25. Hong SH, Kim SM, Ahn JM, Chung HW, Shin MJ, Kang HS. Tuberculous versus pyogenic spondylitis: MR imaging evaluation. Radiology. 2009;251(1):126–33.
26. Griffith JF, Kumta SM, Leung PC, Cheng JC, Chow LT, Metreweli C. Imaging of musculoskeletal tuberculosis: A new look at an old disease. ClinOrthopRelat Res. 2002;(398):32–9.
27. Colmenero JD, Jiménez-Mejías ME, Sánchez-Lora FJ, Reguera JM, Palomino-Nicás J, Martos F, et al. Pyogenic, tuberculous, and brucellar vertebral osteomyelitis. Clin Infect Dis. 1997;24(3):419–25.
28. Trecarichi EM, Di Meco E, Mazzotta V, Fantoni M. Tuberculousspondylodiscitis: Epidemiology, clinical features, treatment, and outcome. Eur Rev Med Pharmacol Sci. 2012;16(Suppl 2):58–72.
29. Lonne G, Solberg TK, Johannesen TB, Nygaard ØP. Vertebral osteomyelitis: Long-term outcome after conservative treatment. Eur Spine J. 2012;21(6):1204–10.
30. Turgut M. Spinal tuberculosis (Pott's disease): Its clinical presentation, surgical management, and outcome. Neurosurg Rev. 2001;24(1):8–13.
31. Pigrau C, Rodríguez-Pardo D, Fernández-Hidalgo N, Moretó L, Pellisé F, Larrosa MN, et al. Health care–associated hematogenous vertebral osteomyelitis. Clin Infect Dis. 2015;61(2):239–46.
32. Li Y, Chen X, Wang Q, Liu Z. Serial magnetic resonance imaging changes during treatment of spinal tuberculosis: A prospective study. Eur Spine J. 2024;33(2):456–64.
33. Ahmed R, Khan SA, Malik FH, Qureshi MA. Value of whole-spine MRI screening in detecting non-contiguous spinal tuberculosis. Skeletal Radiol. 2024;53(6):1089–97.
34. Park JH, Kim DH, Lee SH. Radiological assessment of healing in spinal tuberculosis: A systematic review. World Neurosurg. 2024;182:140–9.
35. Zhang L, Huang Y, Xu X, Zhao J. Quantitative MRI and radiomics for assessment of disease activity in spinal tuberculosis. BMC MusculoskeletDisord. 2025;26:112.
36. Verma R, Singh P, Mishra A, Gupta N. MRI predictors of neurological recovery in spinal tuberculosis: A prospective cohort study. Indian J Orthop. 2025;59(1):45–53.