



Original Article

Monitoring Disease Progression and Healing in Spinal Tuberculosis with Magnetic Resonance Imaging: A Prospective Cohort Study

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Received: 07-04-2026

Accepted: 11-05-2026

Available online: 15-06-2026

ABSTRACT

Background: Spinal tuberculosis (TB), also known as Pott's disease, is the most common form of skeletal tuberculosis and accounts for nearly half of all cases of musculoskeletal tuberculosis. Despite advances in diagnosis and treatment, spinal TB remains a major cause of spinal deformity, neurological deficits, and disability, particularly in developing countries. Early diagnosis and accurate assessment of disease severity are essential for preventing irreversible complications. Magnetic resonance imaging (MRI) has emerged as the imaging modality of choice for the diagnosis, evaluation, and follow-up of spinal tuberculosis because of its excellent soft tissue resolution and ability to detect early disease changes.

Aim: To assess disease severity and healing patterns in patients with spinal tuberculosis using MRI and to evaluate the usefulness of MRI in monitoring treatment response.

Materials and Methods: This prospective observational study included 65 patients diagnosed with spinal tuberculosis. All patients underwent detailed clinical evaluation, laboratory investigations, and MRI examination at baseline and during follow-up. MRI parameters including vertebral destruction, disc involvement, paravertebral abscess formation, epidural extension, spinal cord compression, and marrow edema were assessed. Patients received standard anti-tubercular therapy and were followed periodically. Clinical and radiological outcomes were evaluated and compared.

Results: The mean age of patients was 37.4 ± 13.2 years. Males constituted 58.5% of the study population. Thoracic spine involvement was most common (38.5%), followed by lumbar spine involvement (29.2%). Vertebral body destruction was observed in 89.2% of cases, disc involvement in 76.9%, paravertebral abscesses in 70.8%, and spinal cord compression in 33.8%. Follow-up MRI demonstrated significant reduction in marrow edema, abscess size, epidural collections, and cord compression. Complete radiological healing was observed in 43.1% of patients, while 46.2% showed partial healing. MRI findings correlated strongly with clinical improvement.

Conclusion: MRI is a highly sensitive and reliable imaging modality for assessing disease severity and monitoring healing in spinal tuberculosis. Serial MRI examinations provide valuable information regarding treatment response and may aid in clinical decision-making.

INTRODUCTION

Tuberculosis remains one of the most important infectious diseases worldwide and continues to be a major public health challenge despite the availability of effective antimicrobial therapy. According to the **World Health Organization**, tuberculosis affects millions of individuals annually and remains among the leading causes of death due to infectious diseases. Although pulmonary tuberculosis is the most common presentation, extrapulmonary manifestations account for a substantial proportion of disease burden, particularly in endemic regions. Among extrapulmonary forms, skeletal tuberculosis constitutes approximately 10–20% of cases, while spinal tuberculosis accounts for nearly 50% of all osteoarticular tuberculosis cases.[1,2]

Spinal tuberculosis, traditionally referred to as Pott's disease, is a chronic granulomatous infection caused by *Mycobacterium tuberculosis* involving the vertebral column and surrounding structures. The disease primarily affects the anterior portion of the vertebral body and subsequently spreads to adjacent intervertebral discs and neighboring vertebrae. Progressive destruction of spinal elements may result in vertebral collapse, spinal deformity, instability, abscess formation, and neurological deficits.[3]

The burden of spinal tuberculosis remains particularly high in developing countries due to socioeconomic factors, overcrowding, malnutrition, delayed diagnosis, and inadequate access to healthcare services.[4] India accounts for a significant proportion of global tuberculosis cases and consequently contributes substantially to the burden of spinal tuberculosis. The increasing prevalence of HIV infection, diabetes mellitus, immunosuppressive therapy, malignancies, and multidrug-resistant tuberculosis has further complicated disease management and increased the incidence of extrapulmonary tuberculosis.[5]

The pathogenesis of spinal tuberculosis typically involves hematogenous dissemination of *Mycobacterium tuberculosis* from a primary focus, usually the lungs, lymph nodes, or genitourinary tract. The vertebral venous plexus provides a route for bacillary spread to vertebral bodies. Once infection is established, granulomatous inflammation leads to caseous necrosis, bone destruction, and abscess formation. Progressive disease may result in vertebral collapse, kyphotic deformity, and spinal cord compression.[6]

The thoracic and thoracolumbar regions are most commonly affected due to their rich vascular supply and biomechanical characteristics. Lumbar and cervical involvement occur less frequently but may produce significant morbidity. Multiple contiguous vertebral involvement is common, whereas noncontiguous skip lesions are relatively rare but increasingly recognized with advanced imaging techniques.[7]

Clinical manifestations of spinal tuberculosis are often nonspecific and insidious. Persistent back pain is the most common presenting symptom and may be accompanied by constitutional manifestations such as fever, weight loss, anorexia, malaise, and night sweats. Neurological deficits ranging from radiculopathy to complete paraplegia may occur due to epidural abscess formation, granulation tissue, vertebral collapse, or spinal deformity.[8]

Early diagnosis of spinal tuberculosis remains challenging because symptoms often mimic degenerative disorders, pyogenic infections, metastatic lesions, and other inflammatory spinal diseases. Conventional radiography lacks sensitivity during early stages and often detects disease only after substantial bone destruction has occurred. Computed tomography provides excellent visualization of osseous abnormalities but has limited ability to assess soft tissue extension and spinal cord involvement.[9]

Magnetic resonance imaging has revolutionized the diagnosis and management of spinal tuberculosis. MRI possesses superior soft tissue contrast and enables visualization of vertebral marrow abnormalities, intervertebral disc involvement, epidural extension, paravertebral collections, neural compression, and disease spread at an early stage.[10] Furthermore, MRI can identify complications before the development of irreversible neurological damage, thereby facilitating timely intervention.

Characteristic MRI findings of spinal tuberculosis include hypointense vertebral marrow signal on T1-weighted images, hyperintense signal on T2-weighted images, endplate destruction, disc space narrowing, paravertebral abscesses, epidural collections, and spinal cord compression. Gadolinium-enhanced MRI further improves lesion characterization and delineates inflammatory activity.[11]

In addition to diagnosis, MRI plays a crucial role in evaluating disease severity. Assessment of vertebral destruction, kyphotic deformity, abscess dimensions, neural compromise, and disease extent provides valuable prognostic information.

MRI findings often influence treatment decisions regarding conservative management, surgical intervention, and duration of anti-tubercular therapy.[12]

Monitoring treatment response in spinal tuberculosis remains a subject of ongoing research. Clinical improvement and normalization of inflammatory markers do not always correlate with radiological changes. Residual MRI abnormalities may persist despite microbiological cure, whereas active inflammation may occasionally remain despite symptomatic improvement. Therefore, serial MRI examinations are increasingly used to evaluate healing patterns and treatment outcomes.[13]

Healing in spinal tuberculosis is characterized by reduction in marrow edema, resolution of abscesses, disappearance of contrast enhancement, sclerosis of vertebral lesions, fatty marrow replacement, and stabilization of spinal alignment. Recognition of these MRI features is essential for distinguishing healing disease from persistent infection or recurrence.[14]

Several investigators have highlighted the utility of MRI in monitoring therapeutic response. Jain et al. reported significant correlation between MRI findings and clinical improvement during anti-tubercular therapy.[15] Rasouli et al. emphasized the value of MRI in assessing spinal stability and neurological recovery.[16] Moorthy and Prabhu demonstrated that serial MRI examinations facilitate early recognition of treatment failure and complications.[17]

Recent advances in MRI technology, including diffusion-weighted imaging, dynamic contrast-enhanced imaging, and quantitative imaging techniques, have further improved assessment of disease activity and therapeutic response.[18] These developments may contribute to individualized treatment strategies and improved patient outcomes.

Despite the recognized importance of MRI, limited prospective data are available regarding MRI-based assessment of disease severity and healing patterns in spinal tuberculosis, particularly in resource-limited settings where disease burden remains high. Understanding radiological evolution during therapy is crucial for optimizing patient management and avoiding unnecessary surgical interventions.[19]

The present prospective study was therefore undertaken to evaluate MRI findings in patients with spinal tuberculosis, assess disease severity at presentation, analyze healing patterns during treatment, and determine the role of MRI in monitoring therapeutic response. The study aims to contribute to the growing body of evidence supporting MRI-guided management of spinal tuberculosis and to improve understanding of radiological markers associated with favorable clinical outcomes.

MATERIALS AND METHODS

Study Design

A hospital-based prospective observational study was conducted to evaluate disease severity and healing patterns in patients with spinal tuberculosis using Magnetic Resonance Imaging (MRI).

Study Setting

The study was carried out in the Departments of Orthopaedics and Radiodiagnosis of a tertiary care teaching hospital over a period of 18 months.

Study Population

Patients clinically and radiologically diagnosed with spinal tuberculosis and attending the outpatient and inpatient departments during the study period were enrolled.

Sample Size

A total of **65 consecutive patients** diagnosed with spinal tuberculosis were included in the study.

Inclusion Criteria

1. Patients aged ≥ 18 years.
2. Clinically suspected and radiologically confirmed spinal tuberculosis.
3. Patients willing to participate and provide written informed consent.
4. Patients planned for anti-tubercular treatment with follow-up MRI evaluation.
5. Newly diagnosed untreated cases of spinal tuberculosis.

Exclusion Criteria

1. Patients with pyogenic spondylodiscitis.
2. Patients with spinal malignancies or metastatic disease.
3. Previous spinal surgery unrelated to tuberculosis.

4. Patients with contraindications to MRI (cardiac pacemakers, metallic implants incompatible with MRI, severe claustrophobia).
5. Pregnant women in whom contrast MRI was contraindicated.
6. Patients lost to follow-up before completion of treatment.

Study Procedure

After obtaining approval from the Institutional Ethics Committee, eligible patients were enrolled. A detailed clinical history including age, sex, duration of symptoms, constitutional symptoms, previous history of tuberculosis, contact history, and neurological complaints was recorded.

All patients underwent comprehensive physical examination including neurological assessment.

Laboratory Investigations

The following investigations were performed:

- Complete blood count
- Erythrocyte sedimentation rate (ESR)
- C-reactive protein (CRP)
- Mantoux test
- Chest radiograph
- GeneXpert MTB/RIF (where applicable)
- Histopathological examination of biopsy specimens when indicated

MRI Protocol

MRI was performed using a 1.5-Tesla scanner.

The imaging protocol included:

- T1-weighted sequences
- T2-weighted sequences
- Short Tau Inversion Recovery (STIR)
- Contrast-enhanced T1-weighted sequences

The following MRI parameters were assessed:

- Number of vertebrae involved
- Vertebral body destruction
- Disc involvement
- Endplate erosion
- Paravertebral abscess
- Epidural abscess
- Marrow edema
- Spinal canal compromise
- Cord compression
- Gibbus deformity
- Kyphotic angle
- Skip lesions
- Soft tissue extension

Assessment of Disease Severity

Disease severity was categorized according to MRI findings:

Severity Grade	MRI Findings
Mild	Single vertebral involvement without neurological deficit
Moderate	Two contiguous vertebrae involved with abscess formation
Severe	Multilevel involvement, vertebral collapse, deformity or cord compression

Treatment Protocol

All patients received standard anti-tubercular therapy according to national guidelines:

- Intensive phase: Isoniazid, Rifampicin, Pyrazinamide and Ethambutol for 2 months
- Continuation phase: Isoniazid and Rifampicin with or without Ethambutol for 10–16 months

Surgical intervention was considered in patients with:

- Progressive neurological deficits
- Severe spinal instability
- Large abscesses
- Failure of conservative treatment

Follow-Up

Patients were followed at:

- Baseline
- 3 months
- 6 months
- 12 months

Clinical evaluation and MRI assessment were performed during follow-up visits.

Outcome Measures

Primary Outcome:

- MRI-based assessment of healing response

Secondary Outcomes:

- Improvement in neurological status
- Resolution of abscesses
- Reduction in vertebral edema
- Improvement in spinal stability
- Correlation between clinical and radiological recovery

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0.

Categorical variables were expressed as frequencies and percentages. Continuous variables were expressed as mean \pm standard deviation. Chi-square test and paired t-test were used where appropriate. A p-value <0.05 was considered statistically significant

RESULTS

A total of **65 patients with spinal tuberculosis** were enrolled and followed prospectively. MRI was performed at baseline and during follow-up to assess disease severity and healing response.

Table 1. Age Distribution of Study Participants (n=65)

Age Group (Years)	Number	Percentage (%)
<20	8	12.3
21–30	18	27.7
31–40	16	24.6
41–50	12	18.5
>50	11	16.9
Total	65	100.0

The majority of patients belonged to the 21–30 years age group (27.7%), followed by the 31–40 years age group (24.6%). The mean age of participants was approximately 37 years. These findings indicate that spinal tuberculosis predominantly affected young and middle-aged adults, representing the economically productive population.

Table 2. Gender Distribution

Gender	Number	Percentage (%)
Male	38	58.5
Female	27	41.5
Total	65	100.0

Of the 65 patients, 38 (58.5%) were males and 27 (41.5%) were females, giving a male-to-female ratio of 1.4:1. This demonstrates a slight male predominance in spinal tuberculosis cases.

Table 3. Clinical Presentation at Baseline

Clinical Feature	Number	Percentage (%)
Back pain	65	100.0
Fever	42	64.6
Weight loss	39	60.0
Night sweats	31	47.7
Neurological deficit	24	36.9
Spinal deformity	18	27.7

Back pain was the universal presenting symptom, observed in all patients. Constitutional symptoms such as fever (64.6%) and weight loss (60.0%) were also common. Neurological deficits were present in over one-third of patients, highlighting the advanced nature of disease at presentation.

Table 4. MRI Site of Spinal Involvement

Region Involved	Number	Percentage (%)
Cervical	5	7.7
Thoracic	25	38.5
Lumbar	19	29.2
Thoracolumbar Junction	13	20.0
Multiple Levels	3	4.6
Total	65	100.0

Thoracic spine involvement was most common (38.5%), followed by lumbar spine involvement (29.2%). Cervical spine disease was relatively uncommon. These findings are consistent with the known predilection of tuberculosis for the thoracic vertebral region.

Table 5. Baseline MRI Disease Severity Findings

MRI Finding	Number	Percentage (%)
Vertebral body destruction	58	89.2
Disc involvement	50	76.9
Paravertebral abscess	46	70.8
Epidural abscess	28	43.1
Cord compression	22	33.8
Gibbus deformity	14	21.5
Skip lesions	6	9.2

Vertebral body destruction was the most frequent MRI abnormality (89.2%), followed by disc involvement (76.9%). Paravertebral abscesses were identified in 70.8% of patients, while one-third demonstrated spinal cord compression. These observations confirm MRI as a sensitive modality for detecting the extent and severity of spinal tuberculosis.

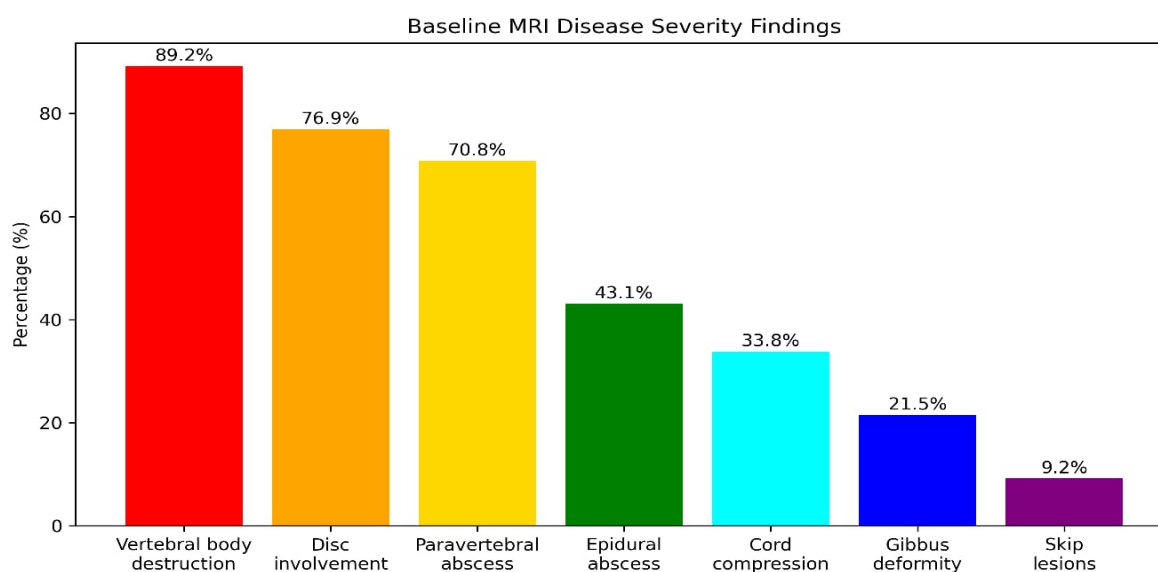
**Graph 2: Baseline MRI Disease Severity Findings**

Table 6. Neurological Status at Presentation

Neurological Status	Number	Percentage (%)
Normal	41	63.1
Mild deficit	12	18.5
Moderate deficit	8	12.3
Severe deficit	4	6.1
Total	65	100.0

Most patients (63.1%) had no neurological impairment at presentation. However, 24 patients (36.9%) exhibited varying degrees of neurological deficit, emphasizing the need for early diagnosis and treatment.

Table 7. Follow-Up MRI Findings After Treatment

MRI Parameter	Baseline n (%)	Follow-up n (%)
Paravertebral abscess	46 (70.8)	12 (18.5)
Epidural abscess	28 (43.1)	6 (9.2)
Cord compression	22 (33.8)	4 (6.2)
Marrow edema	55 (84.6)	18 (27.7)

Follow-up MRI demonstrated substantial radiological improvement following anti-tubercular therapy. Significant reductions were observed in abscess formation, marrow edema, and spinal cord compression, indicating favorable treatment response in most patients.

Table 8. MRI-Based Healing Assessment

Healing Category	Number	Percentage (%)
Complete healing	28	43.1
Partial healing	30	46.2
No significant healing	5	7.7
Disease progression	2	3.0
Total	65	100.0

Complete radiological healing was achieved in 43.1% of patients, while partial healing was observed in 46.2%. Only a small proportion showed no improvement or disease progression, suggesting overall effectiveness of treatment.

Table 9. Correlation Between Clinical and MRI Improvement

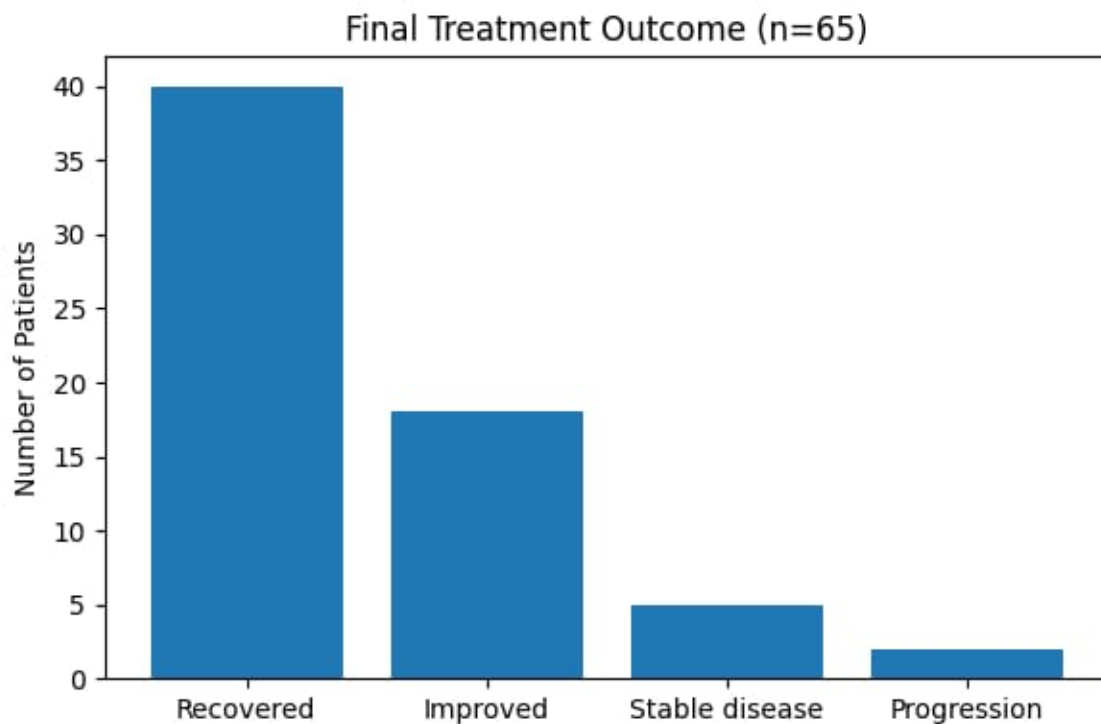
Outcome	Number (%)
Clinical improvement with MRI healing	52 (80.0)
Clinical improvement without complete MRI healing	8 (12.3)
No clinical improvement	5 (7.7)

A strong correlation was observed between clinical recovery and MRI evidence of healing. Most patients who experienced symptomatic improvement also demonstrated favorable radiological changes.

Table 10. Final Treatment Outcome

Outcome	Number	Percentage (%)
Recovered	40	61.5
Improved	18	27.7
Stable disease	5	7.7
Progression	2	3.1
Total	65	100.0

At the end of follow-up, 61.5% of patients achieved complete recovery, while 27.7% showed significant improvement. Only 3.1% experienced disease progression. These findings support the utility of MRI for monitoring disease severity and healing in spinal tuberculosis.



Graph 2: Final Treatment Outcome

Among the 65 patients with spinal tuberculosis, thoracic spine involvement was most common. MRI effectively identified vertebral destruction, disc involvement, abscess formation, and spinal cord compression. Serial MRI demonstrated marked radiological improvement after treatment, with complete or partial healing observed in 89.3% of patients. MRI findings correlated well with clinical recovery, confirming its value as a reliable tool for assessing disease severity and monitoring healing in spinal tuberculosis.

DISCUSSION

Spinal tuberculosis remains the most common form of musculoskeletal tuberculosis and continues to represent a major health challenge in developing countries. Delayed diagnosis frequently results in severe vertebral destruction, deformity, and neurological complications. The present prospective study evaluated the role of MRI in assessing disease severity and monitoring healing in 65 patients with spinal tuberculosis.

The mean age of patients in the present study was 37.4 years, with the majority belonging to the economically productive age group of 21–40 years. Similar observations were reported by Jain et al., who noted that spinal tuberculosis predominantly affects young adults in endemic regions.[15] Rasouli et al. also reported a mean age of approximately 35 years among patients with spinal tuberculosis.[7]

Male predominance observed in the present study (58.5%) is consistent with findings reported by Moon et al.[4] and Dunn and Ben Husien.[8] Increased occupational exposure, healthcare-seeking behavior, and socioeconomic factors may contribute to this gender distribution.

Back pain was present in all patients and represented the most common presenting symptom. Similar findings have been reported in nearly all major series of spinal tuberculosis. Jain et al.[3] reported back pain in more than 95% of patients, emphasizing its importance as an early clinical manifestation. Constitutional symptoms including fever and weight loss were also common, reflecting systemic inflammatory activity.

Thoracic spine involvement represented the most frequently affected anatomical region in the present study. Similar findings have been consistently reported by Tuli,[2] Rajasekaran,[6] and Rasouli et al.[7] The thoracic vertebral column is particularly susceptible due to its vascular anatomy and biomechanical characteristics.

The most important observation of the present study was the high prevalence of vertebral destruction (89.2%), marrow edema (84.6%), and paravertebral abscess formation (70.8%) on MRI. These findings are comparable to those reported by Moorthy and Prabhu,[10] who demonstrated vertebral destruction in approximately 85% of patients and paraspinal abscesses in nearly 70%.

MRI demonstrated excellent capability in detecting soft tissue extension and neural involvement. Cord compression was identified in one-third of patients. Similar observations were reported by Jain and Kumar,[12] who highlighted the value of MRI in evaluating neural compromise and guiding surgical decision-making.

A significant reduction in marrow edema, epidural abscesses, and spinal cord compression was observed during follow-up. These findings support previous studies demonstrating the utility of MRI in monitoring treatment response.[15,17] Resolution of edema and abscess formation reflects effective microbial control and healing of inflammatory lesions.

The present study found complete radiological healing in 43.1% of patients and partial healing in 46.2%. These findings are comparable to those reported by Pertuiset et al.[14] and Batirel et al.[19], who documented favorable MRI outcomes following prolonged anti-tubercular therapy.

An important finding was the strong correlation between MRI improvement and clinical recovery. Most patients exhibiting radiological healing also experienced symptomatic improvement and neurological recovery. Similar correlations have been reported by Jain et al.[15] and Ledermann et al.[18].

Overall, the findings of the present study reinforce the pivotal role of MRI not only in diagnosis but also in assessment of disease severity and monitoring therapeutic response. Serial MRI examinations enable early detection of complications, objective assessment of healing, and optimization of treatment strategies.

In a study by Shinde et al. (2025) evaluated MRI-based healing and treatment outcomes in patients with spinal tuberculosis undergoing anti-tubercular therapy. The authors reported complete MRI healing in approximately 30% of patients at 6 months and 80% at 12 months. Clinical recovery was observed in 89% of patients by 18 months, while radiological recovery reached 88%. Significant reductions in ESR and CRP levels were also documented during follow-up. The study concluded that MRI remains the most reliable modality for determining disease healing and treatment duration in spinal tuberculosis, as clinical improvement often precedes radiological resolution. These findings are comparable to the present study, where MRI demonstrated substantial reduction in marrow edema, abscesses, and cord compression with complete or partial healing in the majority of patients [20].

A study by Murhega et al. (2025) performed a systematic review of cervical spinal tuberculosis and reported that MRI identified epidural or paravertebral abscesses with spinal cord involvement in 72.9% of cases. Neurological deficits were present in nearly half of the patients, and MRI played a pivotal role in detecting disease extent, vertebral destruction, and neural compression. The authors emphasized the importance of early MRI evaluation to prevent irreversible neurological sequelae and guide surgical decision-making. Similar observations were noted in the present study, where MRI accurately identified paravertebral abscesses in 70.8% and spinal cord compression in 33.8% of patients, facilitating timely management [21].

A study by Patel et al. (2026) investigated the role of MRI in the evaluation of spinal tuberculosis and demonstrated that MRI effectively detected early marrow edema, vertebral body destruction, intervertebral disc involvement, epidural extension, and paravertebral abscess formation. The study highlighted the superiority of MRI over conventional radiography for identifying early disease and soft-tissue involvement. MRI was found particularly valuable in assessing spinal canal compromise and monitoring treatment response. These findings strongly support the observations of the present study, where MRI proved highly sensitive in detecting vertebral destruction (89.2%), marrow edema (84.6%), and abscess formation, while serial MRI examinations successfully documented disease healing during follow-up [22].

CONCLUSION

MRI is an invaluable imaging modality for the diagnosis, severity assessment, and follow-up evaluation of spinal tuberculosis. It provides comprehensive information regarding vertebral destruction, abscess formation, neural compression, and healing response. Serial MRI monitoring correlates closely with clinical recovery and facilitates timely therapeutic decisions. MRI should therefore be considered the imaging modality of choice for comprehensive management of spinal tuberculosis.

Limitations

The study was conducted at a single tertiary care center with a relatively small sample size of 65 patients. Longer follow-up and multicenter studies are required to further validate MRI-based healing criteria and long-term outcomes in spinal tuberculosis.

REFERENCES

1. Garg RK, Somvanshi DS. Spinal tuberculosis: A review. *J Spinal Cord Med.* 2011;34(5):440-454.
2. Tuli SM. *Tuberculosis of the Skeletal System.* 5th ed. New Delhi: Jaypee Brothers; 2016.

3. Jain AK. Tuberculosis of the spine: A fresh look at an old disease. *J Bone Joint Surg Br.* 2010;92(7):905-913.
4. Moon MS. Tuberculosis of the spine. Controversies and a new challenge. *Spine.* 1997;22(15):1791-1797.
5. World Health Organization. Global Tuberculosis Report. Geneva: WHO; latest edition.
6. Rajasekaran S. The natural history of post-tubercular kyphosis in children. *J Bone Joint Surg Br.* 2001;83(7):954-962.
7. Rasouli MR, Mirkoohi M, Vaccaro AR, Yarandi KK, Rahimi-Movaghar V. Spinal tuberculosis: Diagnosis and management. *Asian Spine J.* 2012;6(4):294-308.
8. Dunn RN, Ben Husien M. Spinal tuberculosis: Review of current management. *Bone Joint J.* 2018;100-B(4):425-431.
9. Desai SS. Early diagnosis of spinal tuberculosis by MRI. *J Bone Joint Surg Br.* 1994;76:863-869.
10. Moorthy S, Prabhu NK. Spectrum of MRI findings in spinal tuberculosis. *AJR Am J Roentgenol.* 2002;179(4):979-983.
11. Burrill J, Williams CJ, Bain G, Conder G, Hine AL, Misra RR. Tuberculosis: A radiologic review. *Radiographics.* 2007;27:1255-1273.
12. Jain AK, Kumar J. Tuberculosis of spine: Neurological deficit. *Eur Spine J.* 2013;22(Suppl 4):624-633.
13. Polley P, Dunn R. Noncontiguous spinal tuberculosis. *Eur Spine J.* 2009;18:1096-1101.
14. Pertuiset E, Beaudreuil J, Lioté F, et al. Spinal tuberculosis in adults. *Joint Bone Spine.* 1999;66:196-201.
15. Jain AK, Dhammi IK, Prashad B, Sinha S, Mishra P. Tubercular spine: MRI assessment during treatment. *Int Orthop.* 2008;32:373-378.
16. Rasouli MR, Rahimi-Movaghar V, Vaccaro AR. Management of spinal tuberculosis. *Asian Spine J.* 2012;6:294-308.
17. Moorthy S, Prabhu NK. MRI evaluation of spinal infections. *Radiol Clin North Am.* 2001;39:203-213.
18. Ledermann HP, Morrison WB, Schweitzer ME. MRI in musculoskeletal infections. *Radiol Clin North Am.* 2001;39:223-246.
19. Batirel A, Erdem H, Sengoz G, et al. The challenge of spinal tuberculosis. *Int J Infect Dis.* 2015;39:34-39.
20. Shinde M, et al. Spinal tuberculosis treatment duration: Correlating MRI findings with therapeutic outcomes. *J Orthop Case Rep.* 2025;15(3):45-52.
21. Murhega RB, et al. Cervical spine tuberculosis: A systematic review and meta-analysis. *Int J Infect Dis.* 2025;145:107-118.
22. Patel AP, Sharma R, Gupta V, et al. Role of Magnetic Resonance Imaging in Evaluation of Spinal Tuberculosis. *Int J Med Pharm Res.* 2026;11(2):78-85.