VOLUME 10 | ISSUE3

Musculoskeletal Imaging

ORIGINAL ARTICLE

MRI Evaluation of Spinal Tuberculosis: Findings from a Retrospective Study

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SUBMISSION: 16-9-24 | ACCEPTANCE: 24-10-24

ABSTRACT

Introduction: Spinal tuberculosis or Pott's disease accounts for 1–5% of the cases of extrapulmonary tuberculosis. Radiological imaging, specifically medical resonance imaging (MRI), is the preferred tool for effectively diagnosing spinal tuberculosis. We evaluated the MRI features, demographic distribution, and clinical presentation among patients with spinal tuberculosis in a tertiary care hospital in Karad, India.

Material and methods: We retrospectively analyzed data, including medical records and MRI scans of patients with clinically suspected spinal tuberculosis (July 2022 to December 2023). We collected and analyzed the patient demographics, medical and clinical history, and diagnostic data, including plain and contrast-enhanced MRI scans and analyzed.

Results: Of the 36 patients included in the study, 20 (55.6%) were male, and the mean age was 41.6 years. Back pain was the most prominently reported symptom (58.3%). 75% patients had epidural involvement, 38% had endplate irregularity, 33% had vertebral body collapse, and 13.8% had complete vertebral body destruction. All patients had altered signal intensities and 91% had intervertebral disc involvement. 27.8%, 36.1%, and 72.2% of patients had cord edema, cord compression, and thecal compression, respectively. 83.3% patients had pre- and paravertebral abscess and 19% had psoas abscess.

Conclusions: The use of MRI helped us in visualizing features of spinal tuberculosis that would have been difficult with regular radiographs. The outcomes from our study are in line with those reported by previous studies. MRI is the most preferred non-invasive tool for effectively diagnosing and assessing the extent of spinal tuberculosis.

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KEY WORDS

Spinal tuberculous; Pott's spine; epidural abscess; intradural abscess; gibbus deformity; vertebral body collapse; psoas abscess; paravertebral abscess; endplate irregularity

Introduction

The field of radiography has undergone transformations driven by technological advancements, transitioning from manual film processing to automatic processing and eventually adopting digital image processing. This evolution has revolutionized clinical radiography, particularly with the introduction of cross-sectional imaging modalities like CT and MRI. In the context of healthcare infrastructure inadequacies in low-resource settings, a crucial discussion about the future impact of these innovations on clinical radiography practice is warranted [2, 3, 6, 7].

AI, a powerful technology utilizing computer programs to analyze complex data, has proven to be promising in diagnostic imaging, demonstrating high accuracy in detecting small abnormalities in medical images [1, 5, 10]. However, concerns arise regarding the current focus of AI studies on lesion detection without considering the nature or aggressiveness of abnormalities, potentially leading to biased evaluations. Improvements are required by consistently using clinically meaningful endpoints, such as patient survival, symptoms, and the need for treatment, to provide a more comprehensive evaluation of AI's effectiveness in medical imaging [15].

While improved sensitivity is advantageous, it comes with the challenge of detecting subtle changes of indeterminate significance. For instance, in screening mammograms, artificial neural networks exhibit higher sensitivity for pathological findings, including subtle lesions, though not surpassing radiologists' overall accuracy [1, 5]. Incorporating outcome variables like new diagnoses of advanced disease, disease requiring treatment, or conditions likely to affect long-term survival in AI imaging studies to enhance relevance is important [15]. In recent years, the integration of AI technology into healthcare has sparked significant interest and debate among researchers, practitioners, and policymakers. This paper reviews the impact of artificial intelligence on the current healthcare scenario in radiology, highlighting key findings, trends, and future research areas [10, 11, 12].

While AI demonstrates effectiveness in specific tasks, the global replacement of radiology staff is far from possible. AI can be utilized as a supportive tool, emphasizing the importance of communication and collaboration with professionals like engineers and computer scientists [18]. Despite the growing need for AI education for students, residents, and medical specialists, only a limited number of studies have addressed this need in recent years. The consensus advocates for continuous training, starting from the university phase, consolidating during residency or training, and persisting throughout one's professional career [14, 16].

While numerous training programs are available, they often lack integration into the overall learning path. The emerging nature of AI training creates a significant gap between program offerings and the actual needs of radiology staff. It is evident that comprehensive training encompassing the use, benefits, challenges, and implementation issues of AI in clinical departments is essential. This ensures increased confidence among clinicians interested in incorporating AI into their careers. Practical exercises with real AI applications should engage students, teaching them effective and critical usage [4, 8, 9, 13].

Material and methods

Study design

We retrospectively analyzed the data, including MRI images, of patients with suspected spinal tuberculosis at the department of radiodiagnosis in a tertiary care hospital in Karad, India, between July 2022 and December 2023.

Eligibility criteria

Patients of either gender, aged 20 to 80 years, with clinical signs suggestive of spinal tuberculosis, with or without neurological symptoms at the spinal level, were included in the study. Patients with a history of trauma, claustrophobia, metallic implants, cardiac pacemakers, or any cochlear implants were excluded.

Scanning technique

The spinal MRI scan was carried out using standard surface and body coils on a SIEMENS MAGNETOM

AVANTO 1.5 Tesla. A standard protocol and procedure was followed for MRI data collection. Spinal MRI scans were conducted in the sagittal, coronal, and axial planes, utilizing T1, T2, STIR, and post-contrast T1 sequences. A slice thickness of 4 mm was maintained for both sagittal and axial images, with field of view settings of 350 mm for sagittal and 200 mm for axial images. Clariscan (Gadoteric acid) was administered intravenously.

Data collection and analysis

Anonymized data were captured and summarized for this study. Details of patient demographics, clinical history, physical examinations, systemic findings, and laboratory tests were documented. Data for both plain and contrast-enhanced MRI scans were included.

Nominal data were reported as percentages and frequencies, while continuous or discrete variables were summarized with mean, standard deviation, median, minimum, and maximum values. The data are reported descriptively; the data were not tested for any statistical correlation or significance. The data were captured using an Excel sheet and outputs are presented as figures, tables, frequency graphs, and pie charts.

Ethical considerations

The study was conducted in accordance with good clinical practices and the Declaration of Helsinki. Approval from the Institutional Review Board and Institutional Ethics Committee was obtained before commencing the study (Protocol no. 266/2021-2022).

Results

Of the 50 records evaluated for the specified duration, data for 36 patients that met the eligibility criteria were included in the study. The proportion of male patients was higher, and most of the patients were in their thirties (mean age ± standard deviation, 41.6 ± 12.9; Table 1). Back pain was the most commonly reported symptom (n=21) and neurological complaints were reported in 6 patients (Table 1). Seven patients had either a history of tuberculosis, or a family member had tuberculosis, or were immunocompromised due to HIV (Table 1).

The MRI images showed that 28 patients had involvement of two affected vertebrae. The lumbar region was most commonly involved, and epidural abscess was observed in 27 patients. Intradural and intramedullary involvements were rare (Table 1). All patients exhibited abnormal signal changes in the affected vertebrae. Endplate irregularity, vertebral body collapse, and complete destruction of vertebral bodies were observed in 10, 8, and 3 patients, respectively. Two patients had kyphotic deformities during examination (Table 2).

Figure 1 presents the features of intervertebral disc involvement that were observed in MRI scans. Altered signal intensities were observed in all patients, whereas 33 patients had involvement of intervertebral discs. No disc involvement was observed in three patients.

Table 1: Demographic data

Characteristics	Proportion of patients, n (%) N=36
Gender	
Male	20 (55.6)
Female	16 (44.4)
Mean age ± SD, years	41.6 ± 12.9
Age range, years	
21-30	7 (19.4)
31-40	12 (33.3)
41-50	6 (16.7)
51-60	8 (22.2)
61-70	3 (8.3)
History of tuberculosis or immunocompromised condition	
Pulmonary tuberculosis	4 (11.1)
Tuberculosis to a family member	1 (2.8)
HIV/immunocompromised	2 (5.5)
Signs and symptoms	
Fever	3 (8.3)
Back pain	21 (58.3)
Neurological pain	6 (16.7)
Weight loss	1 (2.7)
Multiple symptoms	6 (16.7)
Location of lesion	
Epidural abscess	27 (75.0)
Intra-dural involvement	1 (2.8)
Intra-medullary involvement	1 (2.8)

Table 2: . Vertebral body and pre- and paravertebral soft tissue involvement	
Imaging features	**Proportion of patients, n (%) N=36**
Vertebral body involvement	
Altered signal changes only	3 (8.3)
End plate irregularity	14 (38.9)
Vertebral body collapse/ Compression fracture	12 (33.3)
Complete destruction involving vertebral body	5 (13.9)
Spinal deformity (kyphosis)	2 (5.5)
Pre and paravertebral soft tissue involvement	
Pre- or paravertebral abscess	30 (83.3)
Psoas abscess	7 (19.4)
No pre and paravertebral abscess	6 (16.7)

Cord edema, indicated by increased T2 signal, was observed in 10 patients, while cord compression was observed in 13 patients. Twenty-six patients experienced thecal compression. Pre- and paravertebral involvement was observed in 30 patients and frank psoas abscess was in 7 patients (Table 2).

Discussion

In this retrospective study, we were able to assess the demographic distribution and clinical presentations associated with spinal tuberculosis in patients at a tertiary-care hospital in Karad, India. The proportion of male to female patients was 1.25:1, and the majority of the patients were in their thirties and forties. The most common symptom presented was back pain, while a few patients had multiple signs and symptoms, including fever and neurological pain along with back pain. The majority of patients had the disease located in the lumbar region, and epidural abscess was observed in two-thirds of the patients. Abnormal signal changes in the affected vertebrae were observed in all patients, whereas in three patients there was no disc involvement. Cord edema, cord compression, and thecal compression were seen in 27.8%, 36.1, and 72.2% of patients, respectively. MRI showed pre- and paravertebral involvement in 83.3% of patients. The specific and distinct features of the disease observed in the MRI images in this study further strengthen its importance as a preferred tool for the diagnosis of spinal tuberculosis.

Based on the published literature, overall, the incidence of spinal tuberculosis seems to be higher among males (range, 29%–73%) compared with females [5,13–18]. While the age range varies from 9 to 79 years, the majority of patients diagnosed seem to be living in their third or fourth decade of life [5,13–18]. Even in our study, the proportion of male patients was higher

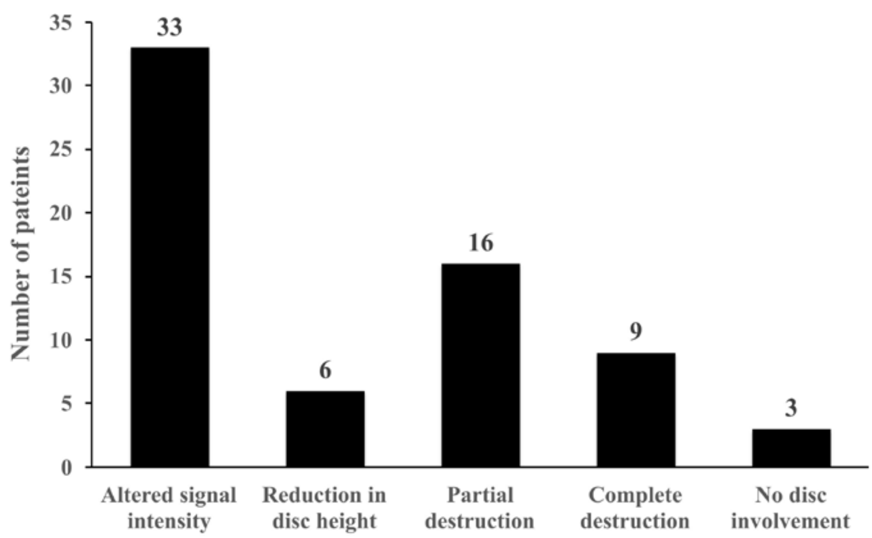

Figure 1: *MRI features of intervertebral disc involvement MRI, medical resonance imaging*

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Figure 2. Case 1
45-year male patient with a history of back ache and fever
Area of altered signal intensity is noted involving opposing end plates of D7 and D8 vertebrae with complete destruction of the disc in between exhibiting hypointense signal on T1WI, hyperintense signal on T2/STIR– Chronic changes of infective Spondylodiscitis. Mild gibbus deformity is noted at D7-8 level just indenting the thecal sac without obvious spinal canal narrowing or cord compression.
T2/STIR hyperintense signal is noted in prevertebral and bilateral paravertebral soft tissue extending from superior border of D7 to inferior border of D8 showing diffusion restriction on DWI/ADC sequences showing post contrast enhancement. Maximum thickness on right paravertebral region is (~ 1.2 cm) and (~ 1.0 cm) in left paravertebral region – Suggestive of cold abscesses.

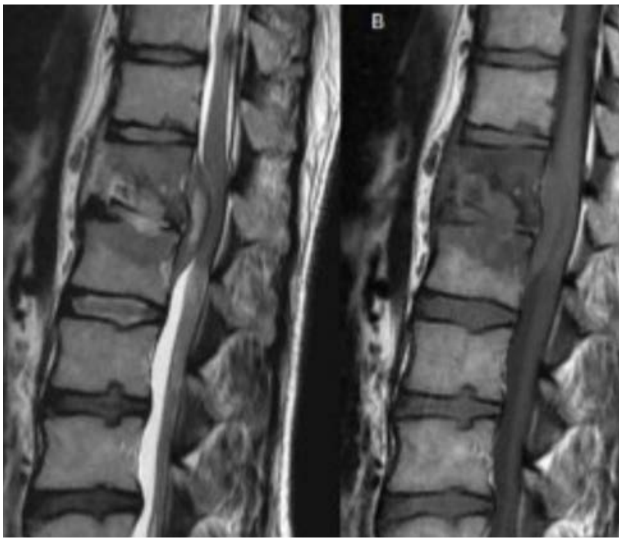

Figure 3. Case 2
45-year female patient with a history of back ache (lower back pain). Known case of Pott's spine.
T2W (A), T1W (B) Saggital MRI images show a small prevertebral abscess.
Area of altered signal intensity is noted involving opposing end plates of D11 and D12 vertebrae with near complete destruction of the disc in between exhibiting hypointense signal on T1WI, hyperintense signal on T2.
T2 hyperintense signal is noted in prevertebral and bilateral paravertebral soft tissue extending from superior border of D11 to inferior border of D12 showing diffusion restriction on DWI/ADC sequences showing post contrast enhancement. Maximum thickness on right paravertebral region is (~ 1.0 cm) and (~ 0.9 cm) in left paravertebral region – Suggestive of cold abscesses.

(55.6%), and almost half of the patients were in their thirties and forties.

Back pain is the predominant symptom among the patients with spinal tuberculosis (range, 9%–100%) [15]. Other commonly reported symptoms include neurological deficits, cough, fever, night sweats, weight loss, and back swelling [5,13–18]. Concomitant active pulmonary tuberculosis and HIV infection have been commonly reported in patients with spinal tuberculosis [5,13–18]. We observed that back pain was reported in 70% of patients, and other commonly reported complaints included neurological deficits, fever, and weight loss. A total of 16.6% of patients had a past history of tuberculosis, while 13.3% had active pulmonary tuberculosis, and 6.6% were HIV-positive.

The thoracolumbar region seems to be the hotspot for spinal tuberculosis, as most of the cases show thoracic, lumbar, or thoracolumbar involvement [15]. The average number of vertebrae affected per patient could range from 1 to 15 [15]. In our study, lumbar, thoracic, and thoracolumbar spine involvement was observed in 55%, 25%, and 13.8% patients, respectively. In our study, a total of 80 vertebrae were affected among the 36 patients, averaging 2.2 vertebrae per patient.

In the present study, all patients exhibited altered signal changes in the affected vertebral bodies. Endplate irregularity was observed in 38% of patients, vertebral body collapse in 33%, and complete vertebral body destruction in 13.8%. Approximately 6.6% of patients had developed spinal deformities before the time of examination. Our findings are similar to those reported by Ansari et al., and Shashikumar et al. [19,20].

In our study, we observed that 91% of patients had intervertebral disc involvement, showing altered signal intensities. This included reduced disc height in 16% of patients, partial disc destruction in 44%, complete disc destruction in 25%, and no disc involvement in 8.3% of patients. Comparable studies by Sinan et al. and Ledermann et al. reported disc involvement rates of 72% and decreased disc height in 50% of cases, respectively [21,22].

Spinal cord involvement, kyphosis, and cord edema are important predictors of neurological deterioration [23–25]. Cord edema, indicated by increased T2 signal intensity, was noted in 27% of patients. The progression of compression in descending order was thecal compression, cord compression, and cord edema. High signal intensity seen on the T2-weighted image within the cord may indicate either cord edema or myelomalacia. It's crucial to differentiate between these conditions because edema is reversible while myelomalacia is not. However, based solely on imaging appearance, distinguishing between cord edema and myelomalacia was not feasible, necessitating consideration of clinical history and disease duration.

Tuberculous arachnoiditis of the spine frequently involves the spinal cord as well as the meninges and nerve roots [26]. Arachnoiditis typically presents as a shaggy appearance at the cord-CSF interface on T1-weighted images and shows meningeal enhancement post-gadolinium. The incidence of tuberculous arachnoiditis varies in the literature, ranging from 9 to 33%. However, the dorsal region is predominantly affected [27,28]. Contradictorily, arachnoiditis as a complication of spinal tuberculosis was not observed in any patient in our study.

Contrast-enhanced MRI using Clariscan™ (gadoterate meglumine) was performed in all cases, revealing two types of enhancement patterns: heterogeneous enhancement of involved vertebral bodies and intervertebral discs and ring-like peripheral enhancement. Epidural and pre- and paravertebral collections showed rim type enhancement with central hypointense areas indicative of necrosis, a characteristic strongly indicative of tuberculous infection compared to non-granulomatous spondylitis. Sagittal and axial MRI images clearly depicted involvement of the spinal cord; 72% of the patients had thecal compression and 36% had actual cord compression.

Tuberculous infection of the spine leads to bone destruction, vertebrae collapse resulting in gibbus or kyphotic deformities, skip lesions, intervertebral disc involvement, epidural abscesses, paravertebral abscesses, psoas abscesses, and soft tissue edema. MRI is crucial for diagnosing spinal tuberculosis, as it clearly reveals these findings. Being a single-center retrospective study has its limitations. The number of patients was small, and being a single-center study, one cannot generalize the study outcomes. Another limitation was that we did not perform spinal biopsy to confirm spinal tuberculosis. Our study confirmed that MRI is a very effective tool for diagnosing and evaluating spinal tuberculosis in its early stages. Including the treatment aspects in our study could have made it more comprehensive.

To summarize, this single-center retrospective study provides the demographic distribution and clinical presentations associated with spinal tuberculosis in 36 patients in a tertiary-care hospital in Karad, India. The observations from our study concur with those reported in literature. The use of MRI was helpful in diagnosing and assessing the extent of spinal tuberculosis. MRI accurately identifies vertebral involvement, intra-osseous abscesses, intervertebral disc issues, skip lesions, involvement of soft tissue, spinal cord impact, and dural and intradural involvement. The study further substantiates the importance of using MRI for diagnosis and evaluation of spinal tuberculosis during its early stages, and sequential MRI scans can accurately monitor treatment response. **R**

Funding: None

Conflict of Interest: The authors do not have any financial or non-financial conflict of interest to declare for this study.

Acknowledgements: The authors would like to acknowledge Lakshya Untwal (Textometry Pvt. Ltd., India) for providing formatting and editorial support in accordance with GPP 2022 guidelines.

Data availability: All collected data are available for this study. Data will be provided upon request.

Author Contributions: All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work. Concept and design: NAL, DRP; Clinical studies: NAL, DRP; Data acquisition and analysis: NAL; Drafting of the manuscript: NAL, DRP; Supervision/Guidance: DRP

References

1. WHO. Global Tuberculosis Programme (who.int). https://www.who.int/teams/global-tuberculosis-programme/tb-reports. Access August 1, 2024
2. WHO. Tuberculosis. https://www.who.int/news-room/fact-sheets/detail/tuberculosis. Access August 1, 2024.
3. WHO. Global Tuberculosis Report 2020. https://www.who.int/publications/i/item/9789240013131. Accessed August 1, 2024.
4. Viswanathan VK, Subramanian S. Pott Disease. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK538331/ Updated August 8, 2023, Accessed on August 1, 2024.
5. Garg B, Mehta N, Mukherjee RN, Swamy AM, Siamwala BS, Malik G. Epidemiological Insights from 1,652 Patients with spinal tuberculosis managed at a single center: a retrospective review of 5-year data. Asian Spine J 2022;16:162–172. doi: 10.31616/asj.2021.0137.
6. Garg RK, Somvanshi DS. Spinal Tuberculosis: a review. J Spinal Cord Med 2011;34:440–454. doi: 10.1179/2045772311Y.0000000023.
7. Glassman I, Nguyen KH, Giess J, Alcantara C, Booth M, Venketaraman V. Pathogenesis, diagnostic challenges, and risk factors of Pott's disease. Clinics and Practice 2023;13:155–165. https://doi.org/10.3390/clinpract13010014
8. Leowattana W, Leowattana P, Leowattana T. Tuberculosis of the spine. World J Orthop 2023;14:275–293. doi: 10.5312/wjo.v14.i5.275.
9. Ansari S, Amanullah MF, Ahmad K, Rauniyar RK. Pott's spine: diagnostic imaging modalities and technology advancements. N Am J Med Sci 2013;5:404–11. doi: 10.4103/1947-2714.115775.
10. Rajasekaran S, Soundararajan DCR, Shetty AP, Kanna RM. Spinal tuberculosis: current concepts. Global Spine J 2018;8:96S–108S. doi:10.1177/2192568218769053
11. Kubihal V, Sharma R, Krishna Kumar RG, Chandrashekhara SH, Garg R. Imaging update in spinal tuberculosis. J Clin Orthop Trauma 2021;25:101742. doi: 10.1016/j.jcot.2021.101742.
12. Rasouli MR, Mirkoohi M, Vaccaro AR, Yarandi KK, Rahimi-Movaghar V. Spinal tuberculosis: diagnosis and management. Asian Spine J 2012;6:294–308. doi: 10.4184/asj.2012.6.4.294.
13. Bhosale S, Prabhakar A, Srivastava S, Raj A, Purohit S, Marathe N. Pattern of drug resistance in primary spinal tuberculosis: a single-center study from India. Global Spine J 2021;11:1070–1075. doi: 10.1177/2192568220941445.
14. Vaishnav B, Suthar N, Shaikh S, Tambile R. Clinical study of spinal tuberculosis presenting with neuro-deficits in western India. Indian J Tuberc 2019;66:81–86. doi: 10.1016/j.ijtb.2018.04.009.
15. Fuentes Ferrer M, Gutiérrez Torres L, Ayala Ramírez O, Rumayor Zarzuelo M, del Prado González N. Tuberculosis of the spine. a systematic review of case series. Int Orthop 2012;36:221-31. doi: 10.1007/s00264-011-1414-4.
16. Liu Z, Wang J, Chen GZ, et al. Clinical characteristics of 1378 inpatients with spinal tuberculosis in general hospitals in south-central China. Biomed Res Int 2019;2019:9765253. doi: 10.1155/2019/9765253.
17. Wang P, Liao W, Cao G, Jiang Y, Rao J, Yang Y. Characteristics and management of spinal tuberculosis in tuberculosis endemic area of Guizhou province: a retrospective study of 597 patients in a teaching hospital. Biomed Res Int 2020;2020:1468457. doi: 10.1155/2020/1468457.
18. Zeng H, Liang Y, He J, et al. Analysis of clinical characteristics of 556 spinal tuberculosis patients in two tertiary teaching hospitals in Guangxi province. Biomed Res Int 2021;2021:1344496. doi: 10.1155/2021/1344496.
19. Ansari S, Rauniyar RK, Dhungel K, et al. MR evaluation of spinal tuberculosis. Al Ameen J Med Sci 2013; 6(3):219-25.
20. Shashikumar MR, Basavaraj SB, Joshi VV, Nanjaraj CP, Rajendrakumar NL. Role of MRI in the Evaluation of Spinal Tuberculosis. Int J Res Med Sci 2015;3:1839–1843. doi: 10.18203/2320-6012.ijrms20150282
21. Sinan T, Al-Khawari H, Ismail M, Ben-Nakhi A, Sheikh M. Spinal tuberculosis: CT and MRI feature. Ann Saudi Med 2004;24:437–441. doi:

10.5144/0256-4947.2004.437.
22. Ledermann HP, Schweitzer ME, Morrison WB, Carrino JA. MR imaging findings in spinal infections: rules or myths? Radiology 2003;228:506–514. https://doi.org/10.1148/radiol.2282020752
23. Garg D, Radhakrishnan DM, Agrawal U, Vanjare HA, Gandham EJ, Manesh A. Tuberculosis of the spinal cord. Ann Indian Acad Neurol 2023;26:112–126. doi: 10.4103/aian.aian_578_22.
24. Mittal S, Yadav G, Ahuja K, Ifthekar S, Sarkar B, Kandwal P. predicting neurological deficit in patients with spinal tuberculosis - a single-center retrospective case-control study. SICOT J 2021;7:7. doi: 10.1051/sicotj/2021002.
25. Sae-Jung S, Wongba N, Leurmprasert K. Predictive factors for neurological deficit in patients with spinal tuberculosis. J Orthop Surg (Hong Kong) 2019;27:2309499019868813. doi: 10.1177/2309499019868813.
26. Chang KH, Han MH, Choi YW, Kim IO, Han MC, Kim CW. Tuberculous arachnoiditis of the spine: findings on myelography, CT, and MR imaging. AJNR Am J Neuroradiol 1989;10:1255–1262.
27. Sharif HS, Aideyan OA, Clark DC, et al. Brucellar and tuberculous spondylitis: comparative imaging features. Radiology 1989;171:419–425. doi: 10.1148/radiology.171.2.2704806.
28. Sharma S, Gupta SK, Varshney A, Sharma A, Bansal A, Choudhary A. A Study of Osteoarticular Tuberculosis in A Tertiary Care Hospital of Bhopal, Madhya Pradesh. Natl J Community Med [Internet]. 2013;4:117–120.

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Nandish A L, Dinesh Ravichandra Potdar. MRI Evaluation of Spinal Tuberculosis: Findings from a Retrospective Study, *Hell J Radiol 2025*; 10(3): 37-44.