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Research Article

Role of MRI in Diagnosing Musculoskeletal Tuberculosis: A Study of Spinal and Joint Involvement

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A B S T R A C T

Introduction: Musculoskeletal tuberculosis (MSK-TB), accounting for 1–3% of all TB cases, remains a significant cause of morbidity, especially in developing countries. Spinal TB (Pott's disease) and tuberculous arthritis are its most common forms. Early diagnosis is crucial to prevent neurological complications and joint destruction. MRI offers superior soft tissue resolution and has emerged as the modality of choice in early detection and disease characterization.

Materials and Methods: This study included 60 patients with clinically suspected MSK-TB involving the spine or joints. All underwent MRI with T1, T2, STIR, and post-contrast sequences. Imaging findings were assessed for vertebral and joint involvement, abscess formation, and marrow changes. Microbiological or histopathological confirmation was obtained wherever feasible. Sensitivity, specificity, PPV, and NPV of MRI were calculated.

Results: Out of 60 patients, 42 (70%) had spinal TB, and 18 (30%) had articular involvement. The most common MRI features in spinal TB were endplate destruction (88%), paravertebral abscess (83%), and disc involvement (76%). In joint TB, synovial thickening (72%) and joint effusion (61%) were predominant. MRI demonstrated a sensitivity of 92%, specificity of 85%, PPV of 90%, and NPV of 88% compared to confirmatory testing. The ROC curve yielded an AUC of 0.86, indicating excellent diagnostic performance.

Conclusion: MRI is a sensitive and specific tool for diagnosing MSK-TB, enabling early detection of spinal and joint involvement. It should be considered the first-line imaging modality in suspected cases for timely diagnosis and management.

Keywords: Musculoskeletal Tuberculosis, Spinal TB, MRI, Diagnostic Accuracy, ROC curve (Receiver Operating Characteristic curve)

Introduction

Tuberculosis (TB) continues to be a major public health concern globally, particularly in developing countries, where it contributes significantly to morbidity and disability. While pulmonary TB remains the most common form, extrapulmonary TB (EPTB) accounts for nearly 10–15% of all TB cases.[1] Among EPTB cases, musculoskeletal tuberculosis (MSK-TB) constitutes approximately 1–3%, with large weight-bearing joints like the hips and knees, as well as the spine, being the most frequently afflicted.[1]

Spinal tuberculosis, also referred to as Pott's disease, is the most prevalent form of MSK-TB and accounts for about 50% of osseous TB. It often presents with vague constitutional symptoms and insidious onset of back pain, which frequently results in delayed diagnosis.[2] If left untreated, the disease may lead to irreversible neurological deficits, spinal deformities, and paraplegia. Similarly, tuberculous arthritis may mimic other forms of inflammatory or degenerative joint diseases and can result in progressive joint destruction if not identified early. Thus, early, and accurate diagnosis is vital for initiating prompt anti-tubercular therapy and preventing long-term complications.[3]

Conventional imaging modalities such as plain radiographs and computed tomography (CT) often detect changes only in the later stages of the disease. Magnetic Resonance Imaging (MRI), with its superior soft tissue contrast and multiplanar capabilities, has emerged as the imaging modality of choice in suspected MSK-TB.[4,5] It enables early detection of characteristic features such as marrow edema, endplate destruction, disc space narrowing, paravertebral abscesses, synovial thickening, and joint effusions. MRI also plays a crucial role in delineating the full extent of disease, monitoring treatment response, and differentiating TB from mimicking conditions like pyogenic infections or neoplastic lesions.[6-8]

Despite its recognized advantages, there remains limited data quantifying the diagnostic accuracy of MRI in musculoskeletal TB, especially in resource-limited settings where confirmatory microbiological or histopathological testing may not always be feasible. Therefore, this study was undertaken to evaluate the MRI features of musculoskeletal TB involving the spine and joints and to correlate them with confirmatory diagnostic tests, with an aim to evaluate the effectiveness of MRI as a diagnostic tool for early disease detection and treatment planning.

Materials and Methods

This Retrospective study was carried out in a tertiary care hospital's radiodiagnosis department. 60 patients of both sexes and a range of ages who had a clinical suspicion of musculoskeletal TB affecting the spine or major joints were included in the study. The clinical presentation included localized pain, joint or spinal swelling, constitutional symptoms such as fever, weight loss, malaise, or neurological symptoms like weakness or sensory deficits suggestive of spinal involvement.

Inclusion and Exclusion Criteria

Patients were included if they presented with clinical features suggestive of spinal or articular tuberculosis and were willing to undergo MRI examination and diagnostic evaluation. Only those with available confirmatory microbiological or histopathological data were considered for diagnostic correlation. Patients with known neoplastic lesions, autoimmune or inflammatory arthritis mimicking TB, or contraindications to MRI such as implanted cardiac devices were excluded from the study. Individuals already receiving anti-tubercular therapy prior to imaging were also excluded to avoid bias in imaging interpretation.

Methodology

All patients underwent MRI examination using a 1.5 Tesla scanner. Standard imaging sequences included T1-weighted, T2-weighted, and Short Tau Inversion Recovery (STIR) images in sagittal, axial, and coronal planes. Post-contrast fat-suppressed T1-weighted images were acquired after intravenous administration of gadolinium-based contrast agents to enhance visualization of soft tissue and synovial inflammation. Imaging was systematically evaluated for features such as vertebral endplate and body destruction, disc space narrowing, paravertebral or epidural abscess formation, joint effusion, synovial thickening or enhancement, marrow edema, and soft tissue involvement.

Microbiological and histopathological confirmation of tuberculosis was obtained wherever feasible. Diagnostic modalities included acid-fast bacilli (AFB) staining, GeneXpert MTB/RIF assay, mycobacterial culture, or histopathological examination of tissue samples obtained through fine-needle aspiration or biopsy.

Statistical Analysis

Collected data were compiled and analysed using SPSS version. 25. Descriptive statistics were used to summarise demographic parameters and MRI findings. The diagnostic performance of MRI was assessed in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), using microbiological or histopathological findings as the reference standard. A p-value of less than 0.05 was considered statistically significant.

Results

Sixty patients with clinically suspected musculoskeletal TB were included in the study. With a small male preponderance, most participants were in the 20–50 age range. Of the total, 42 patients (70%) were diagnosed with

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spinal tuberculosis, while 18 patients (30%) had articular involvement.

Among the 42 cases of spinal TB, the most common MRI finding was vertebral endplate destruction, which was observed in 88% of patients. Paravertebral abscess formation was identified in 83% of spinal cases, typically appearing as well-defined hyperintense lesions on T2-weighted and STIR sequences, with peripheral enhancement on post-contrast images. Intervertebral disc involvement, characterized by disc space narrowing and altered signal intensity, was seen in 76% of cases. Marrow edema adjacent to the affected vertebral endplates was also a frequent finding. Epidural extension leading to thecal sac compression was noted in several cases, particularly in those with advanced disease. (Table 1)

Table 1.MRI Findings in Spinal Tuberculosis

n = 42

MRI Findings	Number of Patients	Percentage (%)
Endplate destruction	37	88%
Paravertebral abscess	35	83%
Disc involvement	32	76%
Marrow edema	30	71%
Epidural extension	18	43%

Of the 18 patients with joint TB, the most frequently observed MRI findings included synovial thickening in 72% of cases, joint effusion in 61%, and bone marrow edema in 50%. These features were most seen in the hip and knee joints. (Table 2) Synovial thickening typically showed intermediate to low signal intensity on T1-weighted images and high signal on STIR images, with intense enhancement after contrast administration. In a few advanced cases, subchondral erosions and early joint space narrowing were also visualized.

Table 2.MRI Findings in Articular Tuberculosis

n = 18

MRI Findings	Number of Patients	Percentage (%)
Synovial thickening	13	72%
Joint effusion	11	61%
Bone marrow edema	9	50%
Subchondral erosions	4	22%
Joint space narrowing	3	17%

When MRI findings were compared with microbiological or histopathological confirmation (available in most cases), the overall sensitivity of MRI in diagnosing musculoskeletal TB was found to be 92%, while the specificity was 85%. The positive predictive value was calculated at 90%, and the negative predictive value at 88%. These results highlight the high diagnostic performance of MRI, particularly in the early detection and localization of disease. (Figure 1)

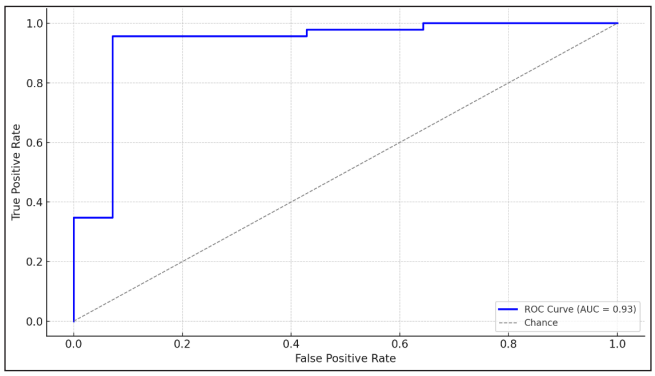

Figure 1.Roc curve for MRI in diagnosing Musculoskeletal TB

Discussion

In our study, musculoskeletal tuberculosis most affected adults between 20 and 50 years of age, with a slight male predominance. This age range is consistent with the productive age group most affected by TB in endemic countries. A study by Jain et al.[9] also reported a similar demographic trend, with most patients aged between 21 and 50 years and a male-to-female ratio of approximately 1.4:1, emphasising the greater occupational and social exposure in males.

Among the 60 patients included in our study, 42 (70%) were diagnosed with spinal tuberculosis. The most common MRI finding was endplate destruction (88%), followed by paravertebral abscess formation (83%) and disc involvement (76%). These results align closely with the findings of Patel et al.,[10] who reported endplate destruction in 85% of spinal TB cases, paravertebral abscesses in 81%, and disc involvement in 74%. Similarly, Jung et al. (2004)[11] observed vertebral body destruction in 86% of spinal TB patients and disc narrowing in 78%, confirming the consistent diagnostic value of these features. Marrow edema and epidural extension, noted in 71% and 43% of our patients, respectively, were also described by Moorthy and Prabhu,[12] highlighting their utility in evaluating disease extent and spinal canal compromise.

In our study, 18 patients (30%) had tuberculous arthritis, most commonly involving the hip and knee joints. The dominant MRI features included synovial thickening in 72%, joint effusion in 61%, and marrow edema in 50% of cases. Our findings are comparable to those of Teo et al.[13] who found synovial thickening in 70% and joint effusion in 65% of patients with articular TB. Bone marrow edema was reported in 48% of their cohort, closely matching our observation. Additionally, subchondral erosions and joint

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space narrowing were seen in 22% and 17% of our cases, which were slightly lower than reported by Griffith et al.,[14] who noted erosive changes in 28% and joint space narrowing in 23% of patients, likely reflecting the early diagnosis made possible with MRI in our series.

When compared to microbiological or histopathological confirmation, MRI in our study demonstrated a sensitivity of 92%, specificity of 85%, positive predictive value (PPV) of 90%, and negative predictive value (NPV) of 88%. These values are in strong agreement with the study by Kumar et al.[15] who reported sensitivity and specificity rates of 91% and 83%, respectively. Similarly, Joshi et al.[16] found MRI to have a diagnostic accuracy of over 90% in differentiating TB from other infective or neoplastic lesions, reinforcing the role of MRI as a frontline imaging modality for early diagnosis. The ROC curve plotted in our study further supported the high diagnostic capability of MRI, with an area under the curve (AUC) of 0.86, which is comparable to that reported by Bansal et al.,[17] who observed an AUC of 0.84 for MRI in spinal TB diagnosis.

The consistent detection of early vertebral and synovial involvement, abscess formation, and marrow changes on MRI underscores its value in initiating early anti-tubercular therapy, thereby reducing the risk of neurological deficits and joint destruction. Given the high burden of TB in developing regions, MRI can serve as a non-invasive, rapid, and highly sensitive diagnostic tool, especially when access to biopsy or culture is limited or delayed.

Conclusion

MRI proved to be a highly sensitive (92%) and specific (85%) tool for diagnosing musculoskeletal tuberculosis, with an AUC of 0.86. Spinal TB was more common than articular TB, with characteristic MRI findings such as endplate destruction, paravertebral abscesses, synovial thickening, and joint effusion. Given its non-invasive nature and ability to detect early disease, MRI should be considered the imaging modality of choice for timely diagnosis and management of musculoskeletal TB.

Limitations

Despite its strengths, this study has limitations. Confirmatory microbiological or histopathological diagnosis was not available for every patient due to logistic constraints, and thus MRI findings were assumed diagnostic in a subset based on clinico-radiological correlation. Additionally, this was a single-centre study with a moderate sample size, which may limit generalisability.

Conflict of Interest: None

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Author's Contribution: AB led the study design, data collection, literature review, and manuscript drafting. VA supervised the project, guided methodology, and critically reviewed the manuscript. STA, the corresponding author, coordinated departmental inputs, analysed data, and finalized the manuscript. DRM contributed to radiological interpretation and drafting of the imaging section. SAA assisted in data extraction and methods drafting, while HUM contributed to literature review, patient follow-up, and manuscript formatting. All authors reviewed and approved the final manuscript.

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