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Evaluating the diagnostic efficacy of T2-weighted and STIR sequences in MRI for detecting Pott's spine: A comparative study

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Abstract
Tuberculous spondylitis, or Pott's disease, is a significant public health issue, especially in resource-limited areas. It results from Mycobacterium tuberculosis infection of the vertebral bodies and intervertebral discs, leading to severe complications such as back pain, kyphosis, and paraplegia. MRI is essential for early diagnosis and evaluation, using sequences like T2-weighted (T2W) and short tau inversion recovery (STIR) to identify key pathological features.
This study aimed to evaluate the effectiveness of MRI, particularly T2 and STIR sequences, in detecting spinal tuberculosis. Conducted at the Radiology Department of Maharishi Markandeshwar Institute of Medical Sciences and Research, it included 30 patients with confirmed Pott's spine. The patient population ranged from 12 to 69 years, with a mean age of 39.2 years. The study found a higher prevalence of tuberculosis in older age groups, with males (57%) more commonly affected than females (43%). Backache (40%) and fever (33%) were the most frequent symptoms. The thoracic spine (30%) was the most commonly involved region, followed by the lumbar spine (27%).
MRI results showed that edema and abscesses were highly visible on both T2W and STIR sequences, with hyperintensity being prominent. Intervertebral disc changes appeared hyperintense on T2W and intensely hyperintense on STIR. Pre and paravertebral collections, vertebral body changes, and neural compression consistently showed high intensity on T2W, while STIR sequences demonstrated pronounced hyperintensity in pre and paravertebral collections, neural compression, and discitis.
In conclusion, MRI, particularly with T2W and STIR sequences, is vital for the precise evaluation and management of Pott's disease. These sequences provide critical insights into the extent and nature of pathological changes, facilitating early diagnosis and effective treatment to prevent severe complications.

Keywords: Spinal tuberculosis, spine, Pott's spine, MRI, T2, STIR

Introduction

Tuberculous spondylitis, often known as Pott disease, involves a tuberculosis infection impacting the vertebral bodies and intervertebral discs. This type of musculoskeletal tuberculosis predominantly affects the spine, resulting in symptoms like back pain, spinal kyphosis, lower limb weakness, and potential paraplegia [1]. Tuberculosis, a disease with a deep historical background, was documented in ancient civilizations like Egypt and Peru around 9000 BCE. Ancient Indian texts, such as the Rig Veda and Atharva Veda, referred to it as 'Yakshama' between 3500 BCE and 1800 BCE. Additionally, in 1779, Sir Percival Pott identified spinal tuberculosis as a condition causing spinal deformities and paraplegia. By 1870, the identification of the mycobacterium as the primary causative agent significantly advanced the management of tuberculosis [2].
Recently, industrialized countries have seen a rise in tuberculosis cases, especially among the immunocompromised, due to international travel and migration. Multidrug-resistant strains from developing nations have become a growing global concern, posing a major public health challenge. In 2016, Southeast Asia contributed to 16.5% of the 10.4 million new TB cases worldwide, with India alone accounting for 23% of these cases, according to the World Health Organization [1].
Approximately eleven million people suffer from tuberculosis, with 150,000 new cases of spinal tuberculosis reported each year. China, India, Nigeria, Indonesia, Pakistan, and South Africa together account for 64% of these cases. In developed nations, increasing rates of immunodeficiency and drug resistance are emerging concerns, while advanced-stage cases remain prevalent in poorer countries. The challenges of global migration and the rise of multidrug-resistant strains are significant. Tuberculosis's resurgence is associated with the increase in chronic diseases and the elevated risk of HIV, which raises the likelihood of developing TB by 21 to 30 times. The World Health Organization's goal to reduce TB incidence by 80% and TB-related deaths by 90% by 2030 is progressing, but achieving true eradication will require improvements in socioeconomic conditions. Until then, tuberculosis continues to be a major global health challenge.
Tuberculosis (TB) is caused by the Mycobacterium tuberculosis complex, which consists of about 60 species. However, only four species—Mycobacterium tuberculosis, Mycobacterium bovis, Mycobacterium microti, and

Mycobacterium africanum—are known to cause disease in humans. Mycobacterium tuberculosis is a slow-growing, aerobic bacillus. TB can affect various organs, including the lungs, lymph nodes, gastrointestinal tract, and genitourinary system. The bacteria can remain dormant for extended periods and multiply every 15-20 hours under aerobic conditions. Spinal TB typically results from the hematogenous spread of the bacteria from another primary site [3].

When air containing Mycobacterium tuberculosis is inhaled into the lungs, it can lead to Pott's disease if the infection spreads to the spine. This spread occurs through hematogenous transmission, where bacteria travel from the lymph nodes or lungs to the spine via the bloodstream. The bacteria disseminate through Batson's plexus, a network of paravertebral veins [1]. The intervertebral disc is an avascular structure receiving blood supply from paradiscal arteries, which makes it vulnerable to different types of involvement. The most frequent is subchondral bone involvement, followed by the development of nonosseous abscesses, posterior involvement, and central involvement. Tuberculosis can induce granulomatous inflammation, marked by lymphocytic infiltration and epithelioid cells, leading to caseating necrosis of the affected tissues and the formation of cold abscesses [3]. Spinal tuberculosis affects many vertebrae due to bifurcation of segmental arteries that supply nearby vertebrae. The infection spreads to numerous contiguous vertebrae under the anterior or posterior longitudinal ligaments.

MRI is the preferred imaging modality as it offers the best opportunity to detect and confirm vertebral infections early in their progression. Initial findings typically show that inflammatory tissue and edema have replaced the normal marrow, accompanied by structural changes such as disk space narrowing. Fat infiltration or edema in the bone marrow leads to decreased signal intensity on T1-weighted images, indicating marrow replacement. Conversely, marrow edema appears with increased signal intensity on fat-saturated T2-weighted and short tau inversion recovery (STIR) images due to the presence of excess water in the marrow [4].

Following MRI sequences are used in the evaluation of Pott's spine:

1. T1 weighted imaging
2. T2weighted imaging
3. STIR imaging.

The aim of the study is to assess the role, of MRI in the detection of spinal tuberculosis, specifically utilizing the T2 and STIR sequences. The study aims to analyze and compare the sensitivity and accuracy of T2 and Short Tau Inversion Recovery (STIR) sequences in detecting spinal TB.

Materials and methods

The study was a descriptive, cross-sectional research conducted in the Radiology Department of Maharishi Markandeshwar Institute of Medical Sciences and Research. MRI case records of 30 patients with proven tuberculosis between 2023 to 2024 were reviewed and relevant clinical history was also noted. Diagnosis was based on history, clinical examination and investigations.

The study was performed using 1.5T Philips Multiva MRI Scanner and 1.5T Philips Achieva MRI Scanner.MRI pulse sequences included T1-weighted (T1W) and T2-weighted (T2W) imaging in both sagittal and transverse orientations, as well as short tau inversion recovery (STIR) sequences in sagittal and coronal planes.

Data collection involved analyzing MRI images observed by radiologists and technologists, with classification by age group and sex. Data were collected from radiological procedures, with informed consent obtained from each patient before the examination. MRI findings were analyzed following each sequence. This descriptive, prospective focused on demographic data, clinical features, and MRI outcomes.

Inclusion criteria were confirmed cases of Pott's spine, OPD and IPD patients, individuals with a history of previous TB, those aged 10-70 years, and follow-up cases. Exclusion criteria included patients with psychological illness, pregnancy, claustrophobia, trauma, or metal implants.

Results

The study included 30 patients aged between 12-69 years, with a mean age of 39.2 years. There was a higher prevalence in older age groups, with 27% in the 51-60 years age group (Table 1). Males (57%) outnumbered females (43%) with a ratio of 1.3:1 (Table 2).

Common presenting complaints were backache (40%) and fever (33%), while loss of appetite and weight loss (13%) was least common (Table 3). The thoracic spine (30%) was most commonly involved, followed by the lumbar spine (27%), with thoracic involvement being highest in the 31-50 years age group (56%) (Table 4).

MRI findings included edema (77%), abscess (53%), vertebral body changes (50%), pre/paravertebral collections (37%), disc changes (37%), discitis (37%), and neural compression (30%) (Table 5).

Patients were evaluated using T2W and STIR MRI sequences to categorize the intensity of various pathological findings. In all cases, edema and abscess showed hyperintensity on both sequences. However, changes in intervertebral discs appeared hyperintense on T2W and intense on STIR. Pre and paravertebral collections, vertebral body changes, neural compression, and discitis consistently appeared intense on T2W, while on STIR, pre and paravertebral collections, neural compression, and discitis showed 100% hyperintensity, with vertebral body changes being intense (Table 6).

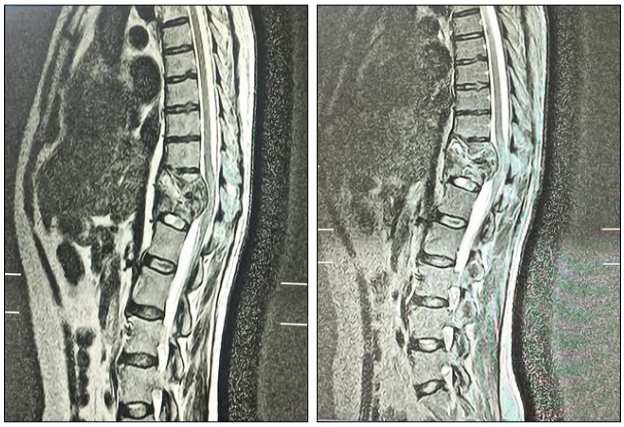

Fig 1: T2w (left) and STIR (right) showing Partial compression/collapse of D11 and D12 vertebrae with extensive cortical and endplate erosions, heterogeneous abnormal marrow signal in D11 and D12 vertebrae: T2 signal: Hypo intense, STIR signal: Heterogeneously hyper intense, abscess (hyper intense)

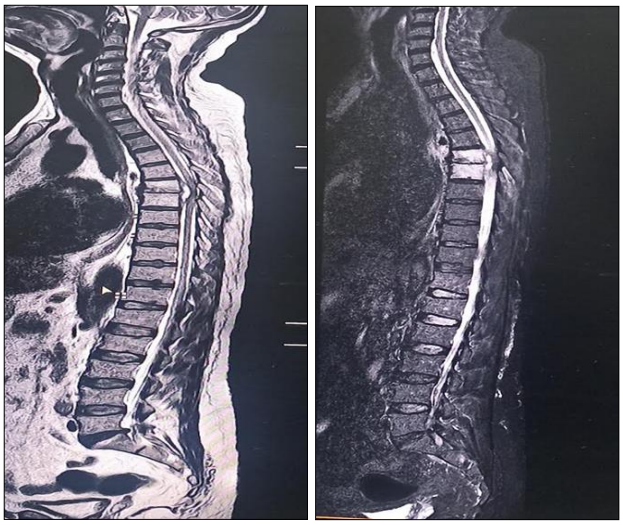

Fig 2: T2w (left) and STIR (right) showing End plate irregularity with marrow edema (STIR hyperintensity), discitis, anterior epidural soft tissue and pre and left paravertebral collection at D10-D11 level. Disc desiccation changes (loss of T2 hyperintensity) at multiple lumbar levels. Fatty end plate changes at L5-S1 level

Table 1: Age Group Distribution of Patients

Age	No. Of Patients	Percentage
11-20y	3	10
21-30	3	10
31-40	6	20
41-50	6	20
51-60	8	27
>60	4	13

Table 2: Distribution of Patients According to Sex

Sex	No. Of Patients	Percentage
Male	17	57
Female	13	43

Table 3: Distribution of Patients According to Clinical Indications

Clinical Indications	No. Of Patients (N)	Percentage (%)
Backache	14	46
Fever	10	33
Paraplegia	7	23
Loss Of Appetite And Weight Loss	4	13
Numbness	5	17
Difficulty To Walk	6	20
Follow Up Case	7	23

Table 4: Distribution of Patients According to Level of Involvement

Level Of Involvement	No. Of Patients	Percentage
Cervical	0	0
Thoracic	9	30
Thoraco Lumbar	2	7
Lumbar	8	27
Lumbo Sacral	4	13
Multiple Level	7	23

Table 5: Distribution of Patients According to MRI Findings

MRI Findings	No. Of Patients	Percentage
Edema	23	77
Abscess	16	53
Pre And Paravertebral Collection	11	37
Changes In Vertebral Body	15	50
Changes In Intervertebral Discs	11	37
Neural Compression	9	30
Discitis	11	37

Table 6: Distribution of Patients According to Characterization of T2W and STIR Sequences in MRI Findings

Clinical Indications	T2W Hyperintense	T2W Intense	STIR Hyperintense	STIR Intense
Edema	23	0	23	0
Abscess	16	0	16	0
Pre And Paravertebral Collection	0	11	11	0
Changes In The Vertebral Body	0	15	0	15
Changes In The Intervertebral Discs	11	0	0	11
Neural Compression	0	9	9	0
Discitis	0	11	11	0

Discussion

Spinal tuberculosis (TB), also known as Pott's disease, is the most common and dangerous form of skeletal TB, accounting for 50% of all skeletal TB cases. [5]In developing countries, the disease progresses quickly, particularly in young individuals, leading to abscess formation and resulting in neurological issues and spinal deformities. Magnetic Resonance Imaging (MRI) is the primary tool for diagnosing spinal TB early and assessing the severity and extent of the infection, revealing bone damage and soft tissue edema [6].

This study included 30 patients diagnosed with Pott's spine in the Radiology Department at MMIMSR, Mullana. Patients' ages ranged from 12 to 69 years, with a mean age of 39.2 years. The study found a higher prevalence of spinal TB in older age groups, particularly 27% in the 51-60 years age group. The male-to-female ratio was 1.3:1, with 57% males and 43% females, aligning with findings from AkankshaRao Bhashyakarla *et al* [5]. and Bhatnagar S. *et al*. [7]

Most patients presented with backache (40%) and fever (33%), with the least common symptoms being loss of appetite and weight loss (13%). The thoracic spine was the most commonly affected (30%), followed by the lumbar spine (27%), similar to the findings of Bhatnagar S. *et al*. [7] Thoracic involvement was most frequent in the 31-50 years age group (56%).

MRI findings included edema (77%), abscesses (53%), changes in the vertebral body (50%), pre and paravertebral collections, changes in intervertebral discs, and discitis (37%), with neural compression being the least observed (30%). These patterns were also observed by Bhatnagar S. *et al*. and Shashikumar MR *et al* [6].

Most lesions were located in the epidural compartment (57%), while 43% were in the extradural compartment, with Shashikumar MR *et al* [6]. reporting a higher epidural collection rate (77%). The anterior type of spinal TB was the most common (37%), while the central type was the least common (10%).

MRI sequences showed hyperintensity in 100% of cases for edema and abscess on both T2W and STIR sequences. On T2W, changes in the intervertebral discs were hyperintense, while on STIR, they were 100% intense. Pre and paravertebral collections, changes in the vertebral body, neural compression, and discitis were 100% intense on T2W. On STIR, pre and paravertebral collections, neural compression, and discitis were 100% hyperintense, while changes in the vertebral body were 100% intense. These observations are consistent with the findings of Saurabh Dwivedi *et al*. **[8]**, who examined lesion intensity on T1W and T2W sequences.

Conclusion

In conclusion, MRI is crucial for evaluating and managing Pott's spine, a condition caused by tuberculosis affecting the vertebral column. Advanced MRI sequences like T2-weighted (T2W) and short tau inversion recovery (STIR) provide detailed images of pathological findings such as edema, abscesses, disc changes, and neural compression. This enables accurate diagnosis, disease assessment, and treatment guidance. MRI's ability to distinguish between various tissues and detect spinal cord compression helps prevent neurological deficits. It is also essential for monitoring treatment response and detecting complications. As a non-invasive imaging tool without ionizing radiation, MRI is indispensable for improving patient outcomes in Pott's spine.

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