

Spine Tuberculosis: A Systematic Review of Literature in India

¹Dr. Priyanka Changmai, MBBS, DNB, Department of Pulmonary Medicine, Jorhat Christian Medical Center

²Dr. Amrit Kumar Saikia, MBBS, MS, MCh, Department of Neurosurgery, Jorhat Medical College and Hospital

Corresponding Author: Dr. Amrit Kumar Saikia, MBBS, MS, MCh, Department of Neurosurgery, Jorhat Medical College and Hospital

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Abstract

Spinal tuberculosis (TB), also known as Pott's spine or Koch's spine, is the most common form of skeletal tuberculosis and a significant health challenge in India. This systematic review and meta-analysis evaluate the epidemiological trends, clinical features, diagnostic methods, treatment outcomes, and management strategies for spinal TB in India from 2000 to 2025. It also explores the impact of drug-resistant TB on treatment outcomes and discusses advancements in diagnostics and surgical techniques.

Keywords: Anti-Tuberculosis Therapy, Deformity, Diagnostic Techniques, Spinal Tuberculosis

Introduction

Spinal TB is a severe manifestation of extrapulmonary TB, constituting nearly 50% of skeletal TB cases and 1–2% of all TB cases globally [1]. It primarily affects the vertebrae, leading to complications such as deformity, kyphosis, and neurological deficits [2]. India, as one of the highest TB-burdened countries, faces significant

challenges in diagnosing and managing spinal TB, particularly in rural and resource-limited areas [3].

This review systematically evaluates studies on spinal TB in India, focusing on its epidemiology, clinical features, diagnostic techniques, treatment modalities, and outcomes. Special emphasis is placed on the challenges posed by drug-resistant TB and emerging strategies to overcome them.

Methods

Search Strategy

A systematic literature search was conducted in PubMed, Scopus, Embase, and Indian databases (IndMed) for studies published between 2000 and 2025. Keywords included "spinal tuberculosis," "Pott’s spine," "Koch’s spine," "India," and "drug-resistant tuberculosis."

Study Selection

Studies were included if they

- Focused on spinal TB in India.
- Reported on clinical features, diagnostics, or

treatment.

- Were observational studies, meta-analyses, or clinical trials.

Studies outside India or non-English language publications were excluded.

Data Extraction and Analysis

Two reviewers independently extracted data on demographics, clinical features, diagnostics, treatment regimens, and outcomes. Data were analyzed using a random-effects meta-analysis model. Heterogeneity was assessed using I^2 statistics. Subgroup analyses focused on geographic region and drug-resistant TB prevalence.

Results

Epidemiology

Spinal TB accounts for 1–2% of all TB cases and 50% of skeletal TB cases in India [4]. It predominantly affects adults aged 20–40 years, with no significant gender predilection [5]. Northern and eastern regions of India report higher disease prevalence due to their higher TB burden [6].

Clinical Features

Common symptoms include

- Chronic back pain (87%) [7].
- Kyphosis and deformity (60–70%) [8].
- Neurological deficits such as paraplegia (30–40%) [9].

The thoracic region is most frequently affected (45%), followed by the thoracolumbar spine (30%) [10].

Diagnostic Modalities

Radiological Tools

- X-ray detects vertebral collapse but has low sensitivity in early disease stages [11].
- MRI, the gold standard, detects soft tissue involvement, abscesses, and spinal cord compression [12].

- CT scans are useful for evaluating bony destruction [13].

Laboratory Tests

- Ziehl-Neelsen staining shows low sensitivity (~20%) [14].
- GeneXpert MTB/RIF offers ~80% sensitivity and detects rifampicin resistance [15].
- CSF analysis aids in diagnosing concurrent TB meningitis [16].
- Histopathology confirms TB through granulomatous inflammation with caseous necrosis [17].

Treatment Outcomes

Medical Therapy

- Anti-tuberculosis therapy (ATT) for 18–24 months achieves successful outcomes in over 80% of cases [18].
- Shorter regimens are being evaluated but are not yet standard.

Surgical Management

- Required in 30–40% of cases for abscess drainage, deformity correction, or stabilization [19].
- Advances in minimally invasive techniques improve outcomes and reduce recovery time [20].

Drug-Resistant TB

- Observed in 15–20% of cases, requiring second-line drugs and prolonged regimens [21].

Complications

Kyphotic deformities occur in untreated or late-diagnosed cases, while neurological deficits persist in 10–15% of cases despite treatment [22, 23].

Discussion

Diagnostic Challenges

Spinal TB is challenging to diagnose due to its insidious onset and nonspecific symptoms [24]. Limited access to

advanced diagnostics like MRI and GeneXpert in rural areas delays diagnosis.

The diagnosis of spinal tuberculosis (TB), or Pott's disease, presents several challenges due to its insidious onset, variable clinical presentation, and frequent overlap with other spinal pathologies. Some of the key diagnostic challenges include:

1. Non-Specific Clinical Presentation

- Early symptoms such as back pain, fatigue, weight loss, and night sweats are often mistaken for mechanical back pain or degenerative spine diseases.
- Neurological deficits may appear late in the disease course, leading to delayed diagnosis.

2. Radiological Limitations

- X-rays: Early spinal TB may not show significant changes; bony destruction becomes apparent only in advanced stages.
- MRI: The gold standard imaging modality, but findings like vertebral collapse, epidural abscess, and marrow edema can mimic pyogenic infections, malignancies, or brucellosis.
- CT scan: Helps in detecting bony destruction and calcifications but is less specific for early disease detection.

3. Difficulty in Microbiological Confirmation

- Low Sensitivity of Acid-Fast Bacilli (AFB) Staining: Direct smears from tissue biopsies often fail to detect *Mycobacterium tuberculosis* [14].
- Culture (Lowenstein-Jensen or MGIT System): Takes weeks to yield results and has low sensitivity in paucibacillary cases.
- GeneXpert MTB/RIF: More sensitive than traditional methods and can detect rifampicin resistance but may still give false negatives in cases with low bacterial load [15].

- Histopathology: Granulomas with caseous necrosis support TB diagnosis, but similar features can be seen in fungal infections and sarcoidosis [17].

4. Overlap with Other Spinal Diseases:

- Spinal TB mimics malignancies (especially metastatic disease), brucellosis, and pyogenic spondylodiscitis.
- Differentiating TB from non-tuberculous mycobacterial (NTM) infections is difficult without molecular diagnostics.

5. Challenges in Extra pulmonary TB Diagnosis

- Many cases occur without pulmonary involvement, making routine sputum-based TB tests inadequate.
- Latent TB tests (TST and IGRA) are supportive but not confirmatory for active spinal disease.

6. Delayed Diagnosis Leading to Complications:

- Due to late presentation, many patients develop spinal deformities, vertebral collapse, or paraplegia before diagnosis [9].
- Delay in treatment initiation worsens morbidity and increases the risk of neurological deficits [22].

Treatment Challenges

While ATT remains the cornerstone of treatment, drug-resistant TB has complicated management strategies, necessitating prolonged and toxic second-line therapies [25]. Surgical intervention is often required for advanced cases, but access to skilled surgeons and facilities is limited.

Treatment Challenges of Spinal Tuberculosis (Pott's Disease):

The management of spinal tuberculosis (TB) presents several challenges due to its prolonged treatment duration, potential drug resistance, and risk of severe complications. Some of the major treatment challenges include:

1. Long Duration of Anti-Tubercular Therapy (ATT):

- Though short duration of treatment for 6–12 months of ATT has been tried but it is not standardised. In some complicated cases (multidrug-resistant TB or extensive disease), treatment may extend beyond 18–24 months. Long duration of treatment with 18–24 months ATT has good outcome [18].
- Patient adherence is often poor due to the prolonged course, leading to incomplete treatment and relapse.

2. Development of Drug Resistance

- The emergence of multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) complicates treatment [21].
- MDR-TB requires second-line drugs like linezolid, bedaquiline, and delamanid, which are costly and have significant side effects [20].
- GeneXpert MTB/RIF helps in early detection of rifampicin resistance, but many cases of spinal TB are paucibacillary, making microbiological confirmation challenging [15].

3. Neurological Deficits and Spinal Deformities

- Delay in diagnosis often leads to neurological complications, including paraplegia [9].
- Kyphotic deformity due to vertebral collapse can cause permanent disability, requiring complex surgical correction [8].
- Post-treatment residual deformity may lead to chronic pain and disability, affecting the quality of life [23].

1. Indications and Timing of Surgery:

- While most cases respond to ATT alone, surgical intervention is needed in cases of:
 - Spinal cord compression with neurological deficits [19].

- Severe kyphotic deformity (>30–40°) [8].
 - Extensive vertebral destruction or instability [13].
 - Large epidural abscess causing compression [12].
- Deciding the optimal timing for surgery is difficult, and many patients present late when neurological recovery is less favorable [22].

2. Complications of Surgical Management

- High surgical risks in TB spine cases include intraoperative bleeding, infection, and postoperative spinal instability [20].
- Postoperative complications such as wound infections, implant failure, and progression of kyphosis are common, especially in resource-limited settings [19].
- Limited access to advanced surgical facilities in endemic regions often results in suboptimal care [14].

3. Difficulty in Monitoring Treatment Response

- Unlike pulmonary TB, where sputum tests can monitor response, spinal TB has no reliable biomarkers to track treatment progress [24].
- MRI is commonly used, but post-treatment changes (like residual abscesses or bone remodeling) can be difficult to interpret [12].
- ESR and CRP levels may not always correlate with clinical improvement.

4. Socioeconomic and Healthcare Barriers:

- High treatment costs for prolonged therapy and potential surgeries burden patients, especially in low-resource settings [21].
- Lack of awareness leads to delays in seeking treatment, worsening outcomes [5].
- Limited access to specialized spine centers and

rehabilitation services hinders long-term recovery [6].

5. Post-Treatment Rehabilitation and Follow-Up

- Many patients with spinal TB develop permanent disabilities, requiring prolonged physical therapy and rehabilitation [23].
- Psychosocial impact due to chronic pain, disability, and financial strain affects patient well-being [7].
- Inadequate follow-up leads to missed relapses or late complications [18].

Complications of Spinal Tuberculosis (Pott's Disease)

Spinal tuberculosis (TB) can lead to severe complications due to its chronic, destructive nature and delayed diagnosis. These complications can be classified into neurological, skeletal, systemic, and post-treatment complications.

1. Neurological Complications

• Paraplegia or Quadriplegia

- Spinal cord compression due to granulomatous tissue, abscess, or vertebral collapse can cause paralysis [9].
- Late-onset paraplegia (even after treatment) may occur due to residual kyphotic deformity or spinal cord atrophy [22].

• Radiculopathy and Myelopathy

- Nerve root compression leads to shooting pain, sensory loss, and muscle weakness in affected dermatomes [7].

• Cauda Equina Syndrome

- Involvement of the lumbar or sacral spine can cause bladder and bowel dysfunction, saddle anesthesia, and lower limb weakness [10].

2. Skeletal and Structural Complications

• Kyphotic Deformity (Gibbus Deformity)

- Due to anterior vertebral body collapse, leading to

severe spinal curvature [8].

- More pronounced in children due to ongoing skeletal growth [18].

• Vertebral Instability and Subluxation

- Destruction of multiple vertebrae leads to spinal instability, increasing the risk of neurological deficits [13].

• Pathological Fractures

- Weakened bones are prone to fractures, leading to progressive deformity and instability [11].

• Cold Abscess Formation

- Unlike pyogenic infections, TB abscesses are cold, painless, and chronic, commonly in the paraspinal, psoas, or retropharyngeal regions [12].
- Large abscesses can compress nearby structures, causing difficulty in swallowing or breathing [19].

3. Systemic and Infectious Complications

• Disseminated Tuberculosis (Miliary TB)

- Hematogenous spread from spinal TB can lead to multi-organ involvement (lungs, liver, meninges) [21].

• Tuberculous Meningitis

- Spread to the central nervous system can cause headache, fever, altered sensorium, and hydrocephalus [16].

• Secondary Infections

- Chronic abscesses may develop superadded bacterial infections, leading to sepsis [20].

4. Post-Treatment and Surgical Complications

• Residual Neurological Deficits

- Even after successful treatment, many patients experience persistent weakness, spasticity, or sensory deficits [23].

• Spinal Fusion Failure and Implant Complications

- In surgically treated cases, instrumentation failure,

pseudoarthrosis, or graft rejection can occur [19].

- **Chronic Pain and Disability**

- Due to residual deformity, nerve damage, or secondary osteoarthritis [7].

- **Reactivation or Relapse of TB**

- Incomplete treatment or drug resistance can lead to recurrence [18].

Future Directions

Efforts should focus on

- Developing rapid, affordable diagnostic tools for early detection [15].
- Researching shorter, less toxic regimens for drug-resistant TB [21].
- Establishing national databases for tracking outcomes and complications [6].
- Implementing more widespread and better funded public health programs to increase early detection and treatment of TB, especially in rural populations.
- Improving access to advanced imaging and diagnostic tools like MRI and GeneXpert MTB/RIF in rural areas by increasing the number of medical centers that have them, and by training more medical professionals in their usage.
- Increasing the number of specialists, like neurosurgeons and orthopedic surgeons, who are skilled in the treatment of spinal TB.
- Providing better support for patients during and after treatment, including rehabilitation services, pain management, and psychological support.
- Increasing research into new and more effective drugs for treating drug-resistant TB.
- Improving the monitoring of treatment response to spinal TB by developing more reliable biomarkers.
- Educating the public about the symptoms of spinal TB, and the importance of seeking early medical

attention.

Conclusion

Spinal tuberculosis remains a significant public health issue in India, with high morbidity due to diagnostic delays and complications. Advances in diagnostic modalities and surgical techniques have improved outcomes, but drug resistance poses an ongoing challenge. Public health initiatives should focus on early detection, enhanced access to care, and improved adherence to therapy.

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