Wah Academia Journal of Health and Nutrition

Homepage: https://wajhn.com/index.php/journal

Original Article

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Diagnostic value of modern imaging modalities in *tuberculous spondylitis*

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Article Information

Received 14 Mar 2026

Accepted 17 Jun 2026

Available online 30 Jun 2026

Keywords: *Tuberculous spondylitis*, Computed tomography, Magnetic resonance imaging, Fistulography, Diagnostic imaging

Abstract

The article considers the evaluation of the informative value and practical significance of modern imaging diagnostic methods (radiography, computed tomography, MRI, and PET/CT) for the timely detection of *tuberculous spondylitis*. The choice of optimal imaging modalities allows increasing the reliability of diagnosis in the early stages, reducing the frequency of complications, optimizing treatment tactics, and decreasing the risk of patient disability. Special attention is paid to the comparative assessment of the diagnostic value of MRI in detecting bone-destructive changes, paravertebral abscesses, and the spread of the inflammatory process.

Introduction

Tuberculous spondylitis (Pott's disease) is a specific infectious form of spinal lesion caused by *Mycobacterium tuberculosis*, and is characterized by non-specific clinical manifestations, which complicates early diagnosis and can lead to diagnostic errors [1,2]. Often, the disease is disguised as other inflammatory or degenerative processes of the spine, and the diagnosis may be suspected only when the therapy for the presumed non-tuberculous pathology is ineffective [2]. In such cases, the early use of imaging methods is a key factor in determining the diagnosis, assessing the extent of the process, and choosing the optimal treatment strategy [3].

Comprehensive diagnostic imaging includes a combination of radiography, computed tomography (CT), magnetic resonance imaging (MRI), and additional imaging modalities. Traditional radiography can reveal macroscopic bone changes, but its sensitivity in the early stages is low: pathological changes become distinct only after significant destruction of the vertebral bodies. More informative in assessing the bone component and the structure of destruction is CT, which allows detailing destructive changes in bone elements, determining the presence of sequestrate, paravertebral abscesses, and more accurately assessing bone architecture [3].

MRI is considered the "gold standard" in the diagnosis of *tuberculous spondylitis* due to its high sensitivity and specificity [4,5], especially in the early stages of the disease. It allows visualizing inflammatory changes in the bone marrow, intervertebral discs, soft tissues, and the epidural space before the appearance of pronounced bone destruction, as well as detecting paravertebral and epidural abscesses. Contrast-enhanced MRI allows additional assessment of the inflammatory process activity. According to studies, the sensitivity of MRI in the diagnosis of *tuberculous spondylitis* reaches about 95%, and specificity — about 94% in detecting early spinal changes.

Modern studies are focused not only on the visualization of pathological changes but also on the differential diagnosis of tuberculous and pyogenic spondylitis [4,6]. Prospective and retrospective studies have identified characteristic MRI signs that help distinguish *tuberculous spondylitis* from a non-specific bacterial infection, which is especially important for prescribing adequate therapy and preventing complications. In addition, modern approaches include a combination of various imaging methods and the development of diagnostic models based on MRI signs, which increases diagnostic accuracy [7,8].

https://doi.org/10.63954/w5k39822

One multicenter retrospective study demonstrated that specific MRI features (e.g., the degree of vertebral involvement and the nature of abscesses) can be used to build diagnostic scales and models that help distinguish *tuberculous spondylitis* from other infectious processes of the spine. Some studies also indicate the prospects of using additional imaging methods, such as PET/CT, to assess disease activity and monitor therapeutic response, which can be especially useful in complex or recurrent forms of *tuberculous spondylitis* [9,10].

Thus, the use of modern imaging methods — from radiography and CT to MRI and specialized image analysis models — provides an earlier and more accurate diagnosis, optimization of treatment strategy, reduction in the incidence of severe complications (neurological disorders, kyphosis, persistent deformities), and reduction in the disability rate of patients with tuberculous spinal lesions.

Aim of the study

The aim of our study was to investigate the informative value and practical significance of modern imaging diagnostic methods (radiography, computed tomography, MRI, and PET/CT) for the timely detection of *tuberculous spondylitis*. Clarifying the role of optimal imaging methods allows increasing the reliability of diagnosis in the early stages of the disease, which contributes to reducing the incidence of serious complications, optimizing treatment tactics, and reducing the level of patient disability. Special attention was paid to evaluating the diagnostic value of MRI compared to traditional imaging methods for detecting bone-destructive changes, the presence of abscesses, and the spread of the inflammatory process.

Materials and methods

The study material was a retrospective analysis of clinical data and imaging records of 73 patients with an established diagnosis of *tuberculous spondylitis* who underwent inpatient treatment at the department of surgical treatment of pulmonary and extrapulmonary tuberculosis of the State Utility Enterprise on the Right of Economic Management "Regional Center of Phthisiopulmonology" of the Turkestan region in the period of 2024–2025.

The examination included:

- Systematic analysis of medical histories, dynamic observation charts, and epicrises.
- Study of all available radiographs, computed tomograms (CT), and magnetic resonance tomograms (MRI) performed prior to the patients' admission to the hospital.
- Evaluation of the informative value of each imaging method by the following parameters: the ability to detect bone changes, intervertebral and epidural pathology, paravertebral abscesses, the degree of destruction of vertebral bodies, and the nature of the inflammatory process.
- Comparison of the results of imaging methods with clinical, laboratory, and morphological data (if available) to confirm the diagnosis.

When evaluating images, modern imaging criteria described in current international guidelines and recently published studies on the differential diagnosis of tuberculous and non-specific spondylitis were used. An analysis of the time to diagnosis depending on the imaging method used was also carried out, which made it possible to assess the impact of the optimal choice of method on the timeliness of diagnosis and patient management tactics.

The data were processed applying statistical methods using software for medical statistics, which allowed determining the sensitivity, specificity, and diagnostic value of the compared imaging methods.

Results

Before admission to the hospital, all patients (n = 73) underwent various imaging diagnostic methods. Plain radiography of the spine in two projections was performed on 33 patients (45.2%). Computed tomography (CT) was performed in 15 patients (20.5%), multislice computed tomography (MSCT) — in 23 patients (31.5%). Magnetic resonance imaging (MRI) was performed on 71 patients (97.2%). In two cases (2.8%), MRI was not performed due to the presence of an implanted pacemaker, which was a contraindication to the study.

In a hospital setting, in 6 patients (8.2%) with fistulous forms of *tuberculous spondylitis*, fistulography was additionally used to clarify the extent of fistulous tracts and their connection with the focus of destruction.

Analysis of the localization of the pathological process showed that tuberculous spinal lesions most often occurred in the lumbar region — in 39 patients (53.4%). The thoracic and thoracolumbar regions were affected less frequently. In most patients, the disease was diagnosed at the peak of the spondylitis phase (clinical and radiological stages 2A–2B).

In 49 cases (67.1%), damage to two adjacent vertebrae was noted, which corresponded to the typical form of *tuberculous spondylitis*. An extensive process with the involvement of three or more vertebral bodies was detected in 19 patients (26.0%).

Thus, the studied group was dominated by patients with already formed destructive changes in the spine and advanced forms of the disease, which indicates the late diagnosis of *tuberculous spondylitis* at the pre-hospital stage.

https://doi.org/10.63954/w5k39822

Discussion

Analysis of our study results showed that in most patients, *tuberculous spondylitis* was detected at the peak of the process, with the involvement of two adjacent vertebrae in 67.1% and widespread damage to three or more vertebral bodies in 26.0% of patients. The high frequency of complications (abscesses, fistulas, neurological disorders — 89.0%) confirms the late seeking of medical care and late diagnosis, which is consistent with current observations in 2020-2025 [1,2,11].

Radiography, performed in 45.2% of patients, showed limited diagnostic value in the early stages of the disease. CT and MSCT (51.9%) allowed accurate visualization of bone changes, especially with limited segment damage and contraindications to MRI [3]. The most informative method turned out to be MRI (97.2%), which allows detecting changes not only in bones but also in soft tissues, epidural complications, and the degree of spinal cord compression, making it the method of choice when spinal tuberculosis is suspected [4,5]. Fistulography (8.2%) was used in patients with fistulous forms to clarify the anatomy of the pathological process.

PET/CT also shows potential in assessing disease activity and monitoring therapy [9,10]. In addition, atypical and noncontiguous forms of spinal tuberculosis described in recent studies require increased diagnostic vigilance, especially in multilevel lesions [13]. Clinical variability and progression patterns of the disease further confirm the need for comprehensive imaging approaches [11,15].

Thus, the comprehensive use of modern imaging methods, especially MRI, ensures timely diagnosis, early detection of advanced and complicated forms of the disease, and a reduction in the risk of severe complications, which is fully consistent with current international data over the past five years.

Conclusion

None of the imaging methods alone gives a complete picture of the pathological process in the spine. Only the complex application of radiography, CT, MSCT, and MRI, as well as, if necessary, fistulography, allows for a reliable assessment of the prevalence of the lesion, soft tissue involvement, the epidural space, and the degree of spinal cord compression.

Modern studies from 2020–2025 confirm that MRI remains the most informative method for detecting early and complicated forms of the disease, while CT and MSCT are effective for local bone lesions and in the presence of contraindications to MRI. The optimal diagnostic decision is achieved by integrating data from imaging methods with anamnestic, clinical, laboratory, and immunological studies, which allows for timely disease detection, reducing the frequency of complications, and choosing the correct treatment tactics.

Thus, the formation of unified diagnostic algorithms, including modern imaging modalities, is a key factor in the early detection and effective management of patients with *tuberculous spondylitis*.

Conflict of Interest: NIL

Funding Sources: NIL

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Declarations:

Authors' Contribution:

- All Authors Conceptualization, data collection, interpretation, drafting of the manuscript and intellectual revisions
- The authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed

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https://doi.org/10.63954/w5k39822