Atypical Osteolytic Lumbar Tuberculosis Similar To Malignant Tumor: A Case Report

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Linfeng Zhou contributed to the study design and drafted the manuscript. Bing Kang performed the collection and collation of data. Jie Gaostudy contributed to the design and oversaw the manuscript drafting process. Songkai Li contributed to the admission and treatment of the patients. Chengwei Yang contributed to confirming the authenticity of all the raw data. All authors have written the manuscript and read and approved the final manuscript.

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The study was conducted with the consent of the patient and their relatives, who signed an informed consent form and agreed to publication.

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The authors declare that they have no competing interests regarding this study.

ABSTRACT

Typical spinal tuberculosis is characterized by vertebral bone destruction, paravertebral abscess formation, and narrowing of the intervertebral disc space, which are readily identifiable and diagnostically conclusive on imaging. In contrast, atypical spinal tuberculosis lacks these hallmark imaging features, making diagnosis challenging and increasing the likelihood of misdiagnosis. Single vertebral involvement is the most common presentation among atypical forms of spinal tuberculosis, typically manifesting as localized lesions within the vertebral body or its attachments. Osteolytic involvement of both the vertebral body and posterior structures is relatively rare. Due to the absence of specific clinical signs, distinguishing this condition from spinal neoplasms can be difficult, which often leads to misdiagnosis. This report discusses a case of spinal tuberculosis with a single vertebral body involvement, where the primary symptom was progressive low back pain in a 59-year-old patient. The lesion involves the posterior part of the vertebral body and its associated structures while sparing the intervertebral disc. The imaging and clinical manifestations closely resemble those of a tumor. After Positron Emission Tomography-Computed Tomography and two pathological examinations, the diagnosis of atypical lumbar spinal tuberculosis was confirmed. The patient was treated with anti-tuberculosis medication and spinal fixation surgery, with satisfactory therapeutic outcomes. Two years of follow-up revealed satisfactory recovery of the vertebral body and its attachments. This case highlights the diagnostic challenges associated with atypical spinal tuberculosis, particularly in the context of osteolytic lesions that mimic malignant tumors.

CASE REPORT

BACKGROUND

Through the analysis of atypical spinal tuberculosis (TB) diagnosis and management process, this report provides the following significance and contributions:

1. Enhanced Diagnostic Vigilance: Atypical spinal TB manifestations (e.g., single-vertebra involvement, absence of paravertebral abscesses, isolated appendicular lesions, lack of systemic symptoms) are frequently misdiagnosed as malignancies (metastatic carcinoma, myeloma), pyogenic spondylitis, or brucellosis. This case underscores the imperative for broader differential diagnoses.

2. Recognition of Atypical Imaging Features: Identification of atypical radiological patterns (e.g., vertebral sclerosis, focal osteolysis, preserved intervertebral disc height) facilitates TB suspicion in the absence of canonical presentations.

3. Surgical Decision-Making Framework: Informs optimal surgical timing (e.g., early spinal stabilization) and complication management strategies.

4. Pathological and Microbiological Corroboration: Highlights the critical role of histopathology (e.g., non-granulomatous inflammation) and molecular diagnostics (Xpert MTB/RIF, PCR) in definitive diagnosis.

5. Expansion of Disease Spectrum Documentation: Provides real-world evidence of clinical heterogeneity in spinal TB, refining disease classification systems.

6. Evidence for International Guidelines: Supports management recommendations for atypical cases in global guidelines (WHO TB guidelines, spinal infection consensuses).

7. Pathogenesis Investigation: Analysis of etiological factors (e.g., host immune status, Mycobacterium tuberculosis virulence variations) advances mechanistic research.

8. Multidisciplinary Collaboration Model: Demonstrates the essential integration of orthopedics, infectious diseases, radiology, and pathology in complex case management.

9. Medical Education Resource: Serves as an instructive clinical case for training diagnostic acumen in rare presentations.

CASE REPORT

Patient Profile

A 59-year-old male was admitted with a 3-month history of progressively worsening low back pain, primarily nocturnal, accompanied by restricted mobility. Additionally, the patient reported intermittent fatigue, night sweats, and a 10 kg weight loss since symptom onset. Magnetic resonance imaging (MRI) performed at another institution revealed bone destruction in the L3 vertebral body and its attachments, leading to further investigation. Upon referral to our hospital, he was initially diagnosed with a suspected spinal tumor (L3).

Clinical Presentation and Physical Examination

The patient did not report fever, cough, or sputum production. Upon admission, his body temperature remained normal, and he had no significant history of malignancy. Physical examination revealed tenderness over the L2-3 spinous processes and adjacent paraspinal areas, with percussion tenderness. The Visual Analog Scale (VAS) score for back pain was 7/10, indicating moderate to severe pain [1].

Laboratory Investigations

Laboratory results showed an elevated white blood cell count (WBC: 10.14×10^9/L), monocyte count (MON: 1.14×10^9/L), erythrocyte sedimentation rate (ESR: 76 mm/h), C-reactive protein (CRP: 41.5 mg/L), interleukin-6 (IL-6: 40.2 pg/mL), and a negative tuberculosis antibody test. **T-cell Spot Assay (T-SPOT) for tuberculosis infection** was positive, while tumor markers were negative. Additionally, the tiger red slide and tube agglutination tests were both negative.

Imaging findings

Chest computed Tomography (CT) revealed secondary pulmonary tuberculosis (Figure 1). Spinal CT demonstrated destructive lesions involving the L3 vertebral body, bilateral pedicles, sacrum, and left iliac bone, raising concern for a malignant process such as multiple myeloma or metastatic carcinoma (Figure 1). Enhanced lumbar MRI further suggested tumor-like lesions with abnormal signals in the L3 vertebral body, bilateral pedicles, and transverse processes (Figure 1). To further refine the diagnosis and rule out potential metastases from other sites, a PET-CT scan was conducted. The results revealed bone destruction in the L3 vertebral body and its associated structures, as well as in the left sacroiliac joint (Figure 1). Additionally, multiple miliary nodules were noted in both lungs, and several lymph nodes were enlarged in the bilateral pulmonary hilum, mediastinum, and right inguinal region, all exhibiting increased fludeoxyglucose (FDG) uptake. These findings are suggestive of [1] tuberculosis involving the L3 vertebra and left sacroiliac joint, which should be differentiated from multiple myeloma and osteolytic bone metastases; a biopsy is recommended for further confirmation; and [2] Type II pulmonary tuberculosis with disseminated systemic lymphadenopathy.

Histopathological Evaluation

The patient underwent an L3 vertebral biopsy under local anesthesia (Figure 2). Histopathological examination of the bone and bone marrow tissue demonstrated scattered plasma cell infiltration without evidence of malignancy (Figure 2). Due to the limited tissue sample, additional biopsy material was recommended. Ten days later, under general anesthesia, a second biopsy was performed at the L3 right pedicle. The histopathology revealed coagulative necrosis, epithelioid cells, Langhans giant cells, and acid-fast bacilli (AFB) on special staining, consistent with tuberculosis (Figure 3). The diagnosis of atypical lumbar tuberculosis was confirmed.

Treatment Approach and Surgical Intervention

The patient was initiated on a standardized four-drug anti-tuberculosis regimen, comprising rifampicin, isoniazid, pyrazinamide, and ethambutol. Given the extensive osteolytic destruction of the vertebral body and the potential risk of local

spinal instability, the Spinal Instability Neoplastic Score (SINS) was employed to assess the degree of instability [2]. The patient scored 10, indicating the potential for instability. To mitigate the risk of pathological fractures and ensure spinal stability, percutaneous pedicle screw fixation was performed, and iliac bone grafting was used to fill the L3 lesion. Postoperative X-rays and CT confirmed optimal placement of the screws and complete grafting of the osteolytic lesion (Figure 3).

The patient experienced significant improvement in symptoms postoperatively, with a reduction in VAS score to 2/10 for back pain. He was able to ambulate with a lumbar brace on the second postoperative day. Upon discharge, follow-up laboratory tests indicated marked improvement, with WBC, ESR, CRP, IL-6, and procalcitonin levels all returning to near-normal values. He was instructed to continue anti-tuberculosis therapy and to attend regular follow-up visits.

FOLLOW-UP

Over the next two years, the patient reported marked alleviation of his symptoms, including a resolution of night sweats and significant weight gain to baseline levels. Follow-up imaging at 3 months and 2 years post-surgery showed good alignment of the spinal fixation, excellent bone fusion, and favorable bone regeneration (Figure 4). Two years later, the patient underwent removal of the lumbar spinal fixation device, marking the conclusion of his treatment (Figure 4).

DISCUSSION

Etiology & demographics

Spinal tuberculosis is a secondary infection typically resulting from hematogenous dissemination of *Mycobacterium tuberculosis*. Tuberculosis predominantly affects vulnerable populations, including individuals with compromised immune systems, the elderly, diabetics, smokers, and alcohol users. Overcrowded settings, such as prisons and detention facilities, further exacerbate the risk. (Human Immunodeficiency Virus) HIV-positive individuals face a 21-30-fold increased risk of developing tuberculosis [3]. Moreover, impoverished communities are disproportionately affected by the disease on a global scale. Bone tuberculosis accounts for approximately 5% of all extrapulmonary tuberculosis cases, with the spine being one of the most commonly affected sites, comprising 50% to 60% of all skeletal tuberculosis cases [4]. Among spinal tuberculosis cases, atypical presentations occur in about 2% of instances [5]. The incidence of spinal tuberculosis involving posterior structures ranges from 2% to 10% of all spinal tuberculosis cases. Isolated vertebral tuberculosis involving both the vertebral body and associated structures, such as the pedicles, is exceedingly rare [6], and cases with both vertebral and adjacent structural involvement have not been reported to date.

Clinical and imaging findings

Typical spinal tuberculosis presents with vertebral bone destruction, paravertebral abscesses, and narrowing of the intervertebral disc spaces. However, the present case of isolated vertebral tuberculosis exhibits atypical features, including involvement of the vertebral body and its attachments without intervertebral disc involvement, and normal disc spacing. These imaging characteristics closely resemble those of metastatic tumors, which complicates the diagnostic process. This phenomenon may be related to Batson's venous plexus [7, 8]. Spinal metastatic tumors can be classified into osteolytic, osteoblastic, and mixed types, with osteolytic lesions often being confused with vertebral tuberculosis. Clinically, spinal metastatic tumors also present nonspecifically, typically beginning with pain, making it challenging to differentiate them from atypical spinal tuberculosis [9, 10].

X-ray imaging is not highly sensitive for early detection of spinal tuberculosis. By the time radiographic signs appear, the disease has typically progressed, often manifesting as disc collapse, vertebral destruction, and kyphotic deformity. However, atypical spinal tuberculosis may not present with characteristic radiographic findings. Although X-ray is not the most sensitive tool for early diagnosis, it remains a valuable screening tool, as approximately 67% of spinal tuberculosis patients have a history of active or prior pulmonary tuberculosis [11]. X-rays can also provide insight into the general location of the disease and the extent of spinal involvement. However, X-ray alone is insufficient to distinguish tuberculosis-affecting attachments from spinal metastases, particularly in cases where the intervertebral discs are not involved [12].

CT scanning is more sensitive than X-ray and helps improve the accuracy of diagnosing early spinal tuberculosis and single vertebral tuberculosis. It can clearly display bone destruction, sclerosis, and paravertebral masses, and is particularly useful in detecting paraspinal soft tissue calcification, which is a hallmark of tuberculosis [13]. CT can also identify the presence of sequestrum, helping to differentiate spinal tuberculosis from metastatic tumors. Furthermore, CT is the best imaging modality for guiding percutaneous vertebral biopsy to obtain tissue samples and confirm the etiology [14]. However, CT is less sensitive than MRI and does not provide clear images of spinal cord compression.

Currently, MRI is the best imaging method for evaluating spinal tuberculosis, with a sensitivity higher than that of X-ray (93%) and a specificity higher than that of CT (96%) [15]. MRI can visualize early subtle lesions, the involvement of vertebrae, the extent of disease, paraspinal abnormalities, and various pathological changes. For patients with clinical symptoms but negative X-ray or CT findings, MRI can serve as a follow-up to prevent missed diagnoses. MRI's multi-planar imaging capabilities allow precise evaluation of the extent of spinal tuberculosis and spinal cord compression [16]. Single vertebral tuberculosis often mimics conditions such as metastatic tumors, osteoporotic fractures, lymphoma, and plasmacytomas on MRI,

with similar findings including low signal on T1-weighted imaging (T1WI) and high signal on T2-weighted imaging (T2WI) [17]. In such cases, MRI's multi-planar reconstruction provides valuable information on the overall spinal morphology, allowing for better observation of subtle pathological changes in the spine and discs, and aiding in differentiation from other conditions.

FDG-PET/CT is a sensitive, non-invasive imaging technique with promising applications for detecting, staging, assessing disease activity, monitoring treatment efficacy, and determining endpoints in spinal tuberculosis management [18]. In patients with a history of pulmonary tuberculosis, typical spinal tuberculosis radiological findings include osteolytic destruction at the upper and lower margins of adjacent vertebrae, disc destruction, and the formation of paravertebral cold abscesses. Although the present case did not exhibit typical disc involvement, there was a small amount of cold abscess formation in the paraspinal area, with a high-density osteoblastic response (bone sclerosis) surrounding the osteolytic lesions in the vertebral body—features rarely seen in metastatic tumors. Coupled with the patient's history of pulmonary tuberculosis and the absence of a primary tumor on full-body PET/CT, PET/CT contributed to the definitive diagnosis of vertebral tuberculosis. In the case of this particular patient, PET/CT played a crucial role in establishing a definitive diagnosis and holds significant potential for diagnostic application in atypical vertebral tuberculosis.

Although imaging plays a crucial role in the diagnosis of tuberculosis, definitive diagnosis relies on pathological examination and culture of specimens. *Mycobacterium tuberculosis* is slow-growing and requires specific conditions for culture, often yielding low detection rates. Percutaneous biopsy can also result in false negatives due to the limited sample size or atypical biopsy sites. When initial biopsy results are inconclusive, additional tissue samples should be obtained. In this case, the first biopsy yielded negative results, while a second biopsy performed at the right pedicle obtained an adequate amount of tissue, providing a clear diagnosis. A study suggests that real-time fluorescent polymerase chain reaction (PCR) technology (Xpert MTB/RIF) has high sensitivity and specificity for diagnosing bone tuberculosis [19].

Treatment and Prognosis

The treatment of spinal tuberculosis includes bot pharmacological and surgical approaches. The primary goal of surgery is to eliminate the spinal lesions, correct spinal deformities, relieve neural compression, and, when necessary, perform spinal fixation. The use of anti-tuberculosis medications (rifampicin, isoniazid, pyrazinamide, and ethambutol) is crucial in the treatment of single vertebral tuberculosis, and it also has an effect on primary tuberculosis lesions present in other parts of the body [20]. There remains controversy regarding the need for surgical intervention in patients with single vertebral tuberculosis, particularly those with small lesions and relatively mild clinical symptoms [21-23].

Surgical treatment should be considered when spinal instability occurs, and the tuberculosis lesions invade the spinal canal, compressing the spinal cord or nerves. The preferred surgical approach typically involves anterior or posterior lesion debridement, structural bone grafting, and appropriate internal fixation to relieve neural compression, remove local lesions, and maintain spinal stability [24]. Previous classification systems for spinal tuberculosis, such as the e GATA(Grading and Assessment of Tuberculosis of the Spin) classification, primarily focus on typical tuberculosis cases, offering limited guidance for atypical cases, and failing to effectively assess spinal stability [25]. Given the extensive osteolytic destruction of the L3 vertebral body and bilateral attachments in this case, we used the SINS to assess spinal stability, which scored 10 points, indicating potential spinal instability. As a result, percutaneous pedicle screw fixation was performed to prevent pathological fractures. Recent studies have proposed an updated spinal tuberculosis stability scoring system, which provides valuable guidance for treatment decisions [26]. Since the tuberculosis lesion within the vertebral body was relatively localized, and following thorough lesion debridement and standard anti-tuberculosis treatment, the recurrence rate of isolated vertebral tuberculosis is low [27]. In this case, two years post-surgery, lumbar spine CT showed near-complete healing of the L3 vertebral body and bilateral attachments, with scattered focal lucency areas. The posterior edge of the vertebral body was well-shaped, and the clinical tuberculosis cure was achieved.

The prognosis of single vertebra tuberculosis is similar to typical spinal tuberculosis. The prognosis is excellent after the appropriate therapeutic intervention. Although rare, single-vertebral tuberculosis can cause serious complications in advanced stages, such as impaired neurological function, kyphotic deformity, and spinal instability.

Differential Diagnoses

Single vertebra tuberculosis presenting with a solitary localized osteolytic lesion is easily confused with secondary deposits in the vertebral body that may have a similar imaging appearance, such as metastatic tumors, osteoporotic fractures, plasmacytoma, eosinophilic granuloma, lymphoma [16].

Metastatic tumors

Malignant tumors commonly affect the thoracic spine, which is the most frequently involved region. The involvement of a single vertebra or posterior elements is indicative of metastatic spread. There may be skipping lesions, and while there is often bone destruction, the intervertebral disc space typically remains unaffected, with no sequestrum formation. Additionally, there is an absence of paraspinal or intraosseous abscesses. On radiographs, metastatic lesions often present as osteolytic destruction. Both CT and MRI scans, in addition to demonstrating the characteristic bone destruction, can clearly reveal soft tissue

involvement and assess the degree of spinal cord compression. CT images typically show minimal destruction of the vertebral cortical bone, with relatively uniform bone density, a relatively localized extent of the lesion, and no surrounding soft tissue masses. The hallmark MRI features of metastatic tumors in the spine include low signal intensity on T1-weighted (T1W) and T2-weighted (T2W) images, as well as on contrast-enhanced scans [28-30].

Osteoporotic fracture

Fractures primarily occur at the thoracolumbar junction, with the most common site being the 12th thoracic vertebra. CT imaging typically reveals irregular density increases within the vertebral body, with fracture lines appearing as linear or irregular low-density areas. These images may also show vertebral body disruption and posterior convexity, along with the invasion of the spinal canal. On MRI, fractures are characterized by low signal intensity on both T1 and T2-weighted images, reflecting the fracture lines or trabecular impaction. The bone marrow signal intensity is relatively preserved, and there is an absence of paraspinal soft tissue or abscess formation. Additionally, diffuse osteoporotic changes may be observed [31,32].

Plasmacytoma

Solitary plasmacytomas, arising from the hematopoietic tissue of the bone marrow, are commonly found in the thoracic and lumbar vertebrae. These lesions typically present as expansile, isolated osteolytic defects involving either the vertebral body or its associated structures, with well-demarcated borders and adjacent sclerotic rims. The radiographic appearance is characterized by osteolytic destruction, which may or may not be accompanied by pathological fractures. On magnetic resonance imaging (MRI), solitary plasmacytomas exhibit hypointensity on T1-weighted images (T1WI) and hyperintensity on T2-weighted images (T2WI). Notably, due to the collapse of the cortical bone, these lesions may present a curvilinear low-signal zone on both T1WI and T2WI, a phenomenon commonly referred to as the "mini-brain" [33].

Eosinophilic granuloma

Eosinophilic granuloma is a disease that presents with bone destruction, histiocytosis, and Langhans' giant cell infiltration. About 15% of solitary eosinophilic granulomas involve the spine. Patients typically present with pain and swelling, which may be exacerbated by pathological fractures. Eosinophilic granulomas usually involve the vertebral body with preservation of the posterior elements. Vertebra plana is a characteristic feature, although this is only seen in about 40% of cases. The thoracic spine is the commonest site of involvement and in half the cases only a single vertebra is affected CT imaging primarily reveals irregular osteolytic destruction of the affected vertebral body, exhibiting irregular morphology and the presence of small fragmented bone fragments within the destruction area. However, the intervertebral space is typically observed to be within normal limits. Additionally, both bone destruction and paraspinal soft tissue swelling can be identified in the appendages.MRI signal characteristics are non-specific, with lesions typically being hypo- to isointense on T1 and hyperintense on T2 and STIR(short-tau inversion recovery) sequences There is often diffuse enhancement in post-contrast imaging [34,35].

Lymphoma

Lymphoma more commonly manifests as secondary involvement of the spine, rather than as a primary spinal lymphoma. The thoracic spine is the most common site for lymphoma metastasis to the spine. On X-ray or CT imaging, vertebral lesions may present as osteolytic, "ivory "vertebrae, or as severely compressed or flattened vertebrae, necessitating the consideration of lymphoma in the differential diagnosis. Paraspinal soft tissues or the epidural space may be involved across multiple planes, typically demonstrating homogeneous mild high signal intensity with uniform enhancement. MRI findings include bone marrow infiltration and epidural soft tissue masses, with T1-weighted images (T1WI) showing high signal intensity akin to that of bone marrow. T2-weighted images (T2WI) exhibit variable signal intensity, often presenting mild hypointensity, with uniform contrast enhancement, further aiding in the characterization of the lesion [36].

SUMMARY

This report discusses an unusual case of single vertebral tuberculosis with atypical imaging features. Despite undergoing X-ray, CT, and MRI examinations, the possibility of a metastatic tumor could not be excluded. Ultimately, the diagnosis of atypical lumbar spine tuberculosis was confirmed following PET-CT and two percutaneous biopsy procedures. Although several imaging techniques are available for diagnosing spinal tuberculosis, none can reliably differentiate between spinal infections and tumors, highlighting the necessity of histopathological examination to confirm the diagnosis or, at the very least, exclude a neoplastic etiology. In addition to standard anti-tuberculosis drug therapy, surgical intervention should be considered when spinal instability occurs and the tuberculous lesion involves the spinal canal, causing compression of the spinal cord or nerve roots, in order to prevent severe complications.

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TEACHING POINT

Single vertebral tuberculosis often lacks the classic radiological and clinical features typically associated with spinal tuberculosis, complicating both diagnosis and treatment. As a result, patients are frequently diagnosed at a later stage, missing the opportunity for early intervention. The imaging

findings of atypical spinal tuberculosis can easily be confused with other spinal pathologies, particularly metastatic spinal tumors, which further complicates the diagnostic process. A key area for future research lies in the development of non-invasive, efficient, and accurate diagnostic methods for early detection of this condition, enabling timely intervention and improved patient outcomes.

QUESTIONS

Question 1: Which of the following populations are at higher risk for spinal tuberculosis?

1. Individuals with healthy immune systems.
2. Elderly individuals, diabetics, smokers, and alcohol users. (applies)
3. Only individuals with active pulmonary tuberculosis.
4. Individuals with compromised immunity. (applies)
5. Athletes and adolescents.

Explanation:

1. Individuals without healthy immune systems.

2. Elderly individuals, diabetics, smokers, and alcohol users are prone to developing spinal tuberculosis.

Some individuals with weakened immunity and underlying health conditions are also susceptible to spinal tuberculosis.

People with weakened immunity are prone to developing spinal tuberculosis.

Athletes and adolescents are not susceptible to spinal tuberculosis.

[Tuberculosis predominantly affects vulnerable populations, including individuals with compromised immune systems, the elderly, diabetics, smokers, and alcohol users. Overcrowded settings, such as prisons and detention facilities, further exacerbate the risk.]

Question 2: What is the advantage of CT scanning over X-ray in diagnosing spinal tuberculosis?

1. It better shows early spinal tuberculosis.
2. It displays vertebral bone destruction and paraspinal masses. (applies)
3. It is less sensitive to soft tissue calcification.
4. It does not help diagnose tuberculosis.
5. It is more sensitive to soft tissue masses. (applies)

Explanation:

1. In the early diagnosis of spinal tuberculosis, CT has more advantages than X-rays. [CT scanning is more sensitive than X-ray and helps improve the accuracy of diagnosing early spinal tuberculosis and single vertebral tuberculosis.]

2. CT provides a clearer view of bone destruction and paraspinal masses than X-rays. [It can display bone destruction, sclerosis, and paravertebral masses, and is particularly useful in detecting paraspinal soft tissue calcification, which is a hallmark of tuberculosis]

3. It is more sensitive to soft tissue calcification.[It can clearly display bone destruction, sclerosis, and paravertebral masses, and is particularly useful in detecting paraspinal soft tissue calcification, which is a hallmark of tuberculosis]

4. CT can help improve the accuracy of diagnosing early spinal tuberculosis[CT scanning is more sensitive than X-ray and helps improve the accuracy of diagnosing early spinal tuberculosis and single vertebral tuberculosis.]

5. CT has a higher sensitivity for soft tissue than X-rays. [It can clearly display bone destruction, sclerosis, and paravertebral masses, and is particularly useful in detecting paraspinal soft tissue calcification, which is a hallmark of tuberculosis]

Question 3: Which imaging technique is most sensitive for early diagnosis of spinal tuberculosis?

1. X-ray.
2. Computed tomography (CT).
3. Magnetic resonance imaging (MRI). (applies)
4. Positron emission tomography (PET/CT).
5. Ultrasound.

Explanation:

Magnetic resonance imaging (MRI) is the most sensitive imaging technique for the early diagnosis of spinal tuberculosis. [Currently, MRI is the best imaging method for evaluating spinal tuberculosis, with a sensitivity higher than that of X-ray (93%) and a specificity higher than that of CT (96%).]

Question 4: What is the primary goal of surgical intervention in the treatment of spinal tuberculosis?

1. To completely cure the tuberculosis.
2. To eliminate the spinal lesions, correct spinal deformities, and relieve neural compression. (applies)
3. To prevent the spread of Mycobacterium tuberculosis.
4. To replace pharmacological treatment.
5. all patients require surgery.

Explanation:

1. Spinal tuberculosis is difficult to cure solely through surgery; medication support is also required.[The primary goal of surgery is to eliminate the spinal lesions, correct spinal deformities, relieve neural compression, and, when necessary, perform spinal fixation.]

2. The primary goal of surgery is to eliminate the spinal lesions, correct spinal deformities, relieve neural compression, and, when necessary, perform spinal fixation. [The primary goal of surgery is to eliminate the spinal lesions, correct spinal deformities, relieve neural compression, and, when necessary, perform spinal fixation.]

3. Surgery alone cannot prevent the spread of Mycobacterium tuberculosis in spinal tuberculosis. [The use of anti-tuberculosis medications (rifampicin, isoniazid, pyrazinamide, and ethambutol) is crucial in the treatment of single vertebral tuberculosis, and it also has an effect on primary tuberculosis lesions present in other parts of the body]

4. Surgery cannot replace drug therapy. [The use of anti-tuberculosis medications (rifampicin, isoniazid, pyrazinamide, and ethambutol) is crucial in the treatment of single vertebral tuberculosis, and it also has an effect on primary tuberculosis lesions present in other parts of the body]

5. Not all patients require surgery.[The primary goal of surgery is to eliminate the spinal lesions, correct spinal deformities, relieve neural compression, and, when necessary, perform spinal fixation.]

Question 5: The following needs to be differentiated from

single vertebral tuberculosis?

1. metastatic tumors. (applies)
2. osteoporotic fractures. (applies)
3. Plasmacytoma. (applies)
4. eosinophilic granuloma. (applies)
5. Lymphoma. (applies)

Explanation:

[Single vertebra tuberculosis presenting with a solitary localized osteolytic lesion is easily confused with secondary deposits in the vertebral body that may have a similar imaging appearance, such as metastatic tumors, osteoporotic fractures, plasmacytoma, eosinophilic granuloma, lymphoma]

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FIGURES

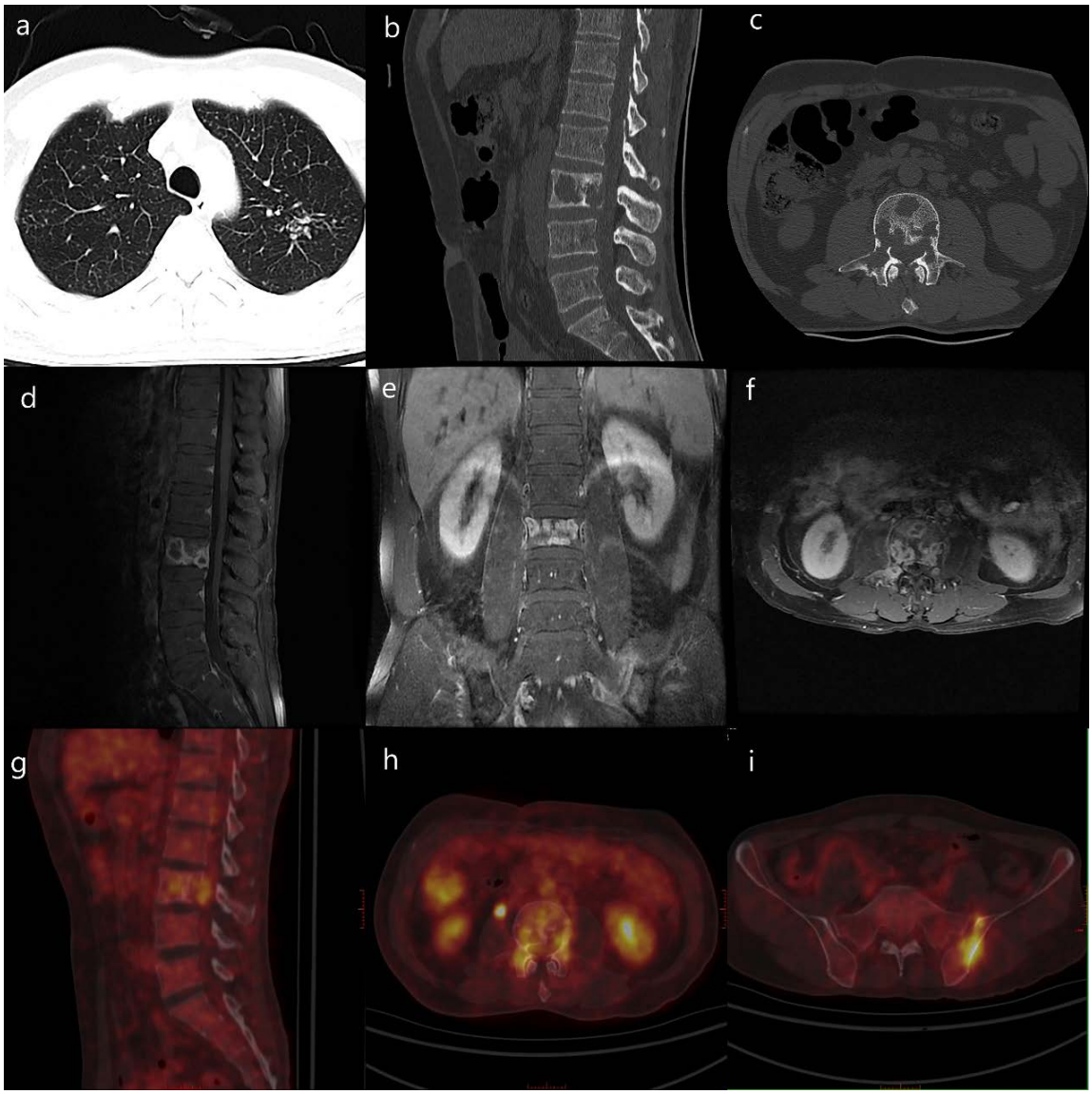

Figure 1: 59-year-old male with single vertebra tuberculosis

Findings:

(a-axial view) Chest CT revealed bilateral pulmonary multifocal nodules and fibrotic opacities, which are indicative of probable secondary pulmonary tuberculosis.

Technique: CT chest without contrast, lung window

(b-sagittal view; c-axial view) Spinal CT demonstrated destructive lesions involving the L3 vertebral body, bilateral pedicles, and transverse processes.

Technique: CT chest without contrast, bone window

(d-sagittal view, e-coronal view, f-axial view) Enhanced lumbar MRI further suggested tumor-like lesions with abnormal signals in the L3 vertebral body, bilateral pedicles, and transverse processes.

Technique:1.5 Tesla enhanced MR scanner, a-sagittal view(TE 10, TR 650), e-coronal view (TE 10, TR 650), f-axial view (TE 10, TR 713).

(g-sagittal view; h-axial view, i-axial view) PET-CT, metabolic inhomogeneous abnormally elevated 18F-FDG in the L3 vertebrae and appendages, as well as in the left sacroiliac joint with an SUVMAX of 6.70.

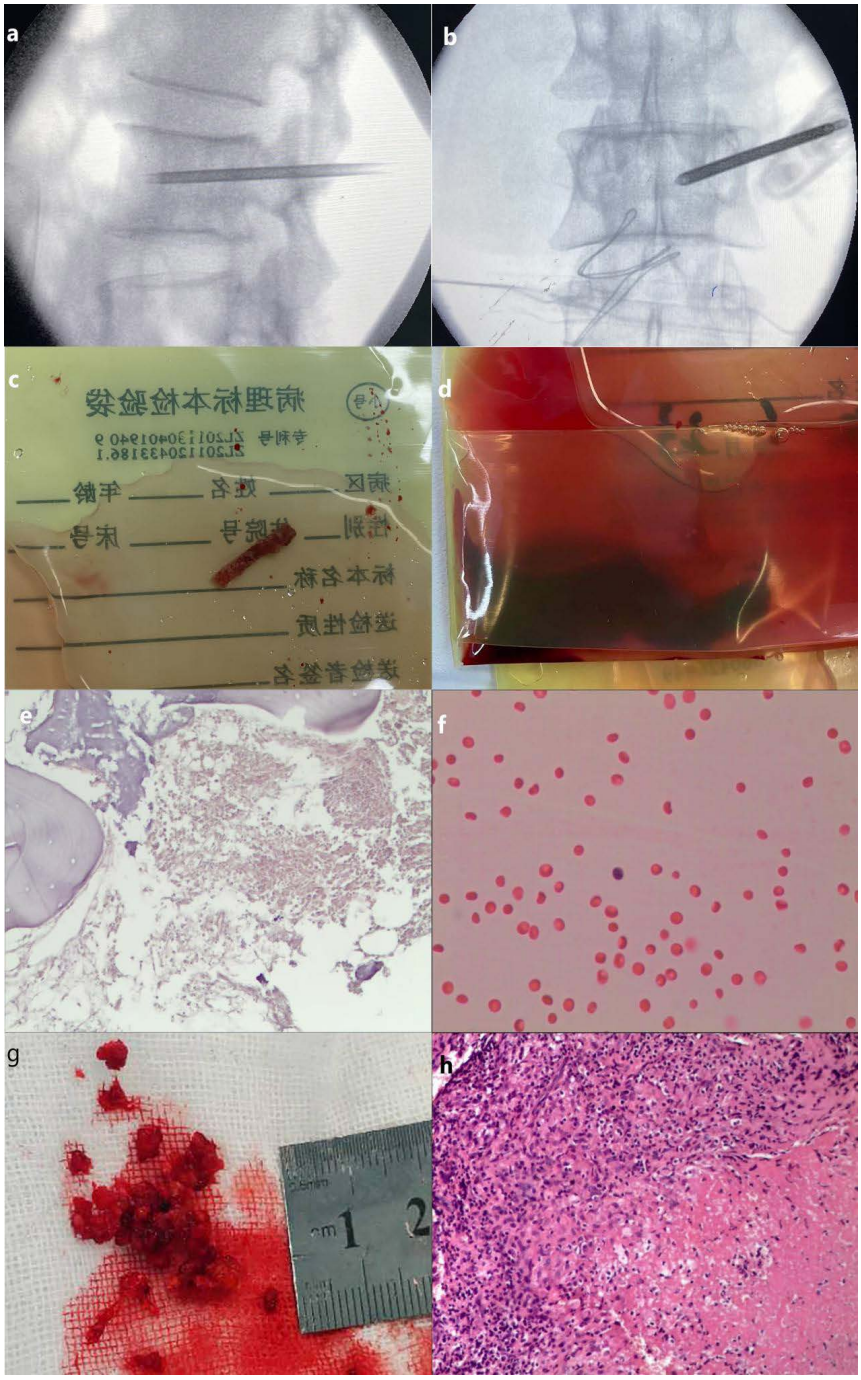

Figure 2: 59-year-old male with single vertebra tuberculosis

Findings:

Intraoperative X-ray: a-Lateral view (Technique: 2.89 mA, 60kV), b-AP view (Technique:3.00 mA, 61kV) showing percutaneous lumbar vertebral biopsy at L3 under local anesthesia.

c: A piece of bone tissue, with dimensions 1.6 cm × 0.2 cm × 0.2 cm.

d: Intraoperative bone marrow aspirate

e: Bone tissue and bone marrow tissue show scattered plasma cell infiltration in the marrow cavity upon immunohistochemical staining, with no clear neoplastic features observed. (The lesion specimen is derived from Figure c.)

f: Against a background of red blood cells, a few lymphocytes and a few neutrophils are seen, but no tumor cells are identified. (The specimen is derived from Figure d.)

g: A pile of grayish-red fragmented tissue, measuring 3 cm×1.5 cm×0.5 cm in volume.

h: Coagulative necrosis and epithelioid cells are visible, with the formation of Langhans giant cells. Special staining results: Acid-fast (+/-), PAS(-). (The specimen is derived from Figure g.)

Technique: Histopathological examination

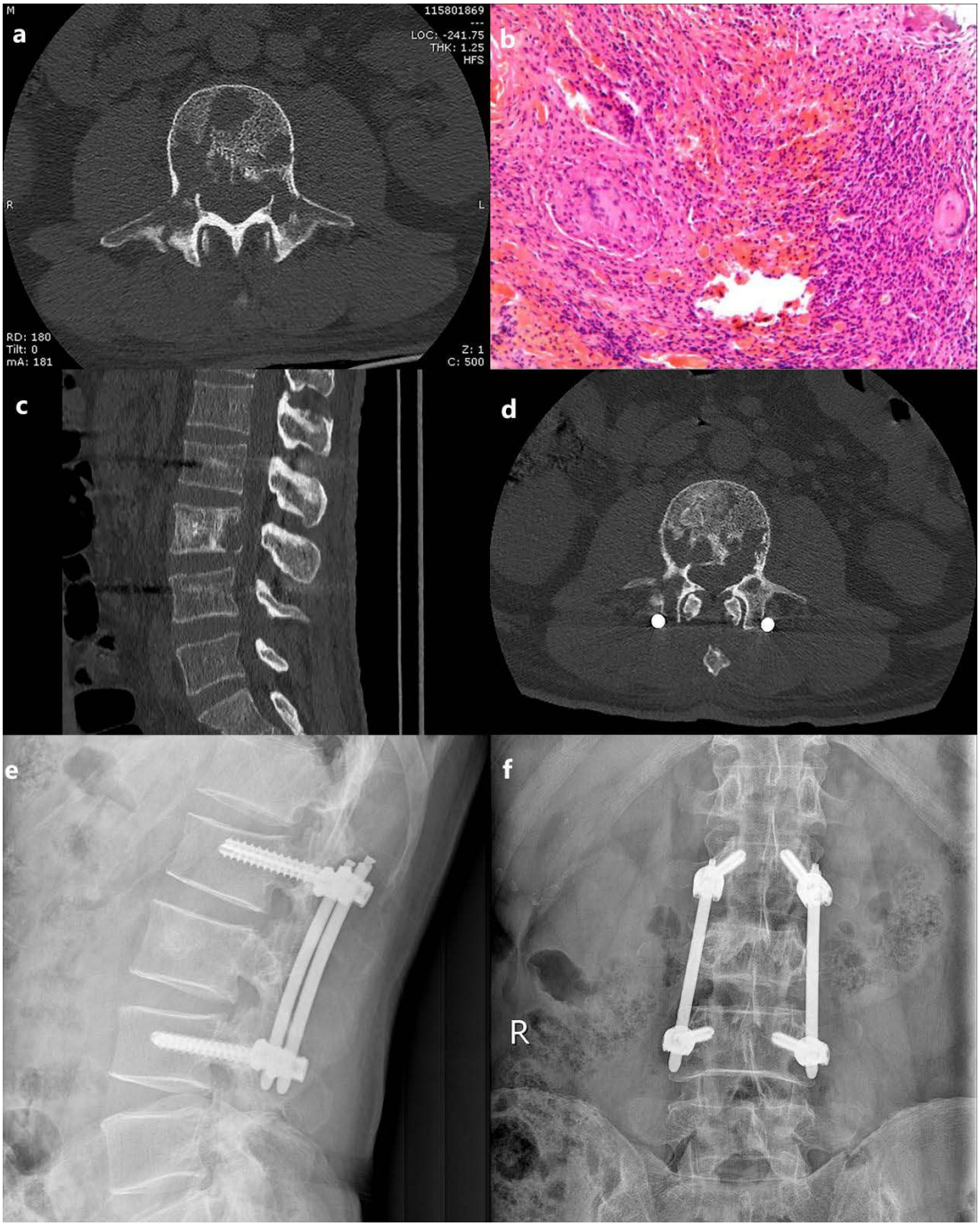

Figure 3: 59-year-old male with single vertebra tuberculosis

Findings:

(a-axial view)Postoperative CT imaging following the second procedure of curettage for pathological bone tissue within the L3 vertebra via the right pedicle.

Technique: CT spine without contrast, bone window

b: In the fragmented bone and inflammatory granulation tissue, a small amount of coagulative necrosis, epithelioid cells, and multinucleated giant cells are seen, which is consistent with the diagnosis of tuberculosis.

Technique: Histopathology Photomicrographs

(b-sagittal view; d-axial view) : Postoperative CT imaging following the second procedure of curettage and bone grafting for pathological bone tissue within the L3 vertebra via the right pedicle.

Technique: CT spine without contrast, bone window

a- Lateral view (Technique: 66 mAs, 84.8kV), b-AP view (Technique: 31 mAs, 80.9kV) showing postoperative re-examination of lumbar spine lesion: The physiological curvature of the lumbar spine is present. Vertebral bodies from L2 to L4 are within the metal posterior internal fixation. The bone density of the L3 vertebral body is unevenly increased with a round low-density area observed. The intervertebral spaces are not narrowed.

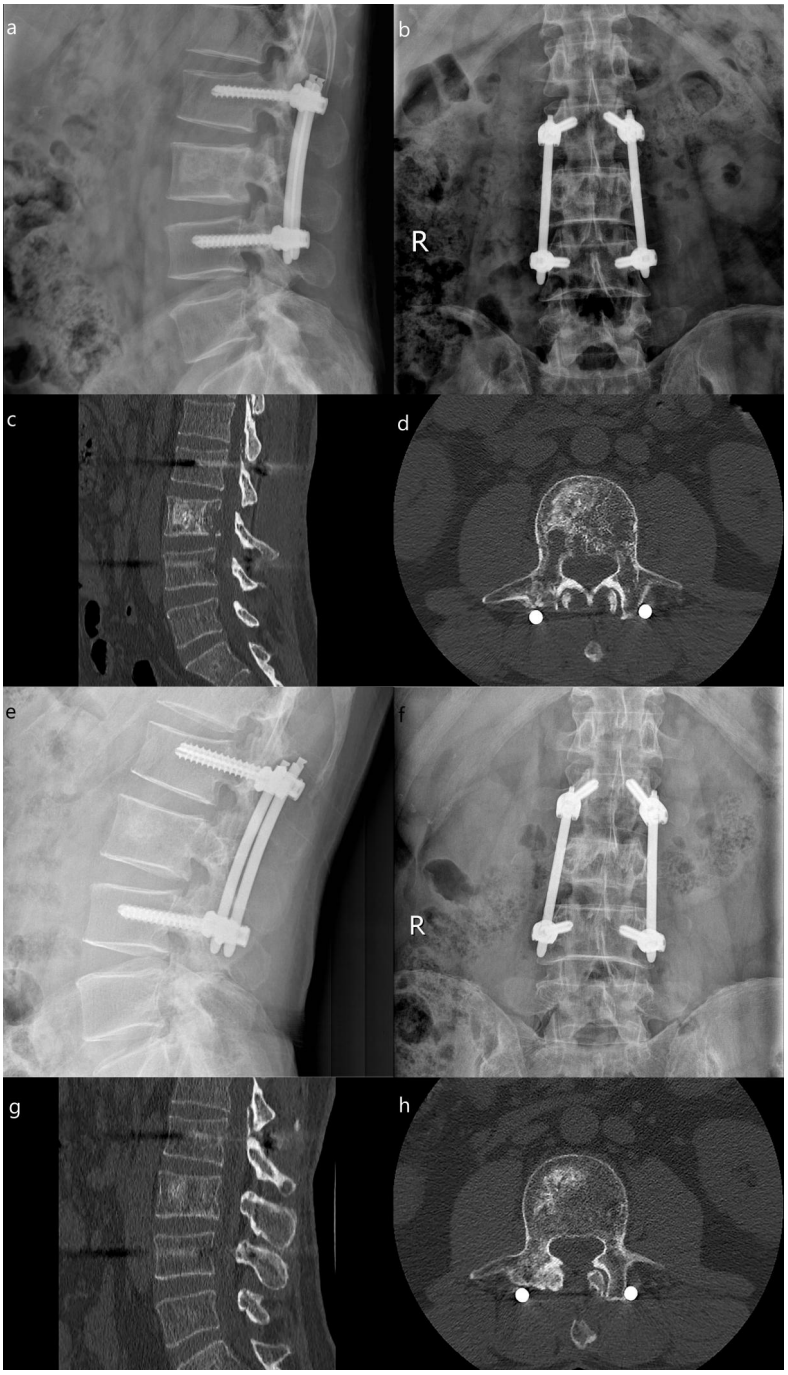

Figure 4: 59-year-old male with single vertebra tuberculosis

Findings:

Postoperative three-month X-ray:a-Lateral view (Technique: 49 mAs, 84.8 kV), b-AP view (Technique: 20 mAs, 80.9 kV) showing the physiological lordosis of the lumbar spine is present, and L2-4 are stabilized with internal fixation via a posterior approach using metal instrumentation.

Postoperative three-month CT:□c-sagittal view; d-axial view□lumbar spine CT revealed near-complete healing of the L3 vertebral body and bilateral attachments, with scattered focal lucency areas. The posterior edge of the vertebral body was well-shaped, and the clinical tuberculosis cure was achieved.

Technique: CT spine without contrast, bone window

Postoperative X-ray at two years: e-Lateral view (Technique: 220 mAs, 89.7 kV), f-AP view (Technique: 145 mAs, 80.7 kV) showing the physiological lordosis of the lumbar spine is present, and L2-4 are stabilized with internal fixation via a posterior approach using metal instrumentation.

Postoperative CT at two years□g-sagittal view; h-axial view□ reveals scattered punctate and patchy lucent areas within the L3 vertebral body and bilateral pedicles, with peripheral lesions exhibiting patchy areas of high-density sclerosis.

Table 1: Summary table of single vertebra tuberculosis

Etiology	Hematogenous spread of Mycobacterium tuberculosis
Incidence *	the incidence of atypical spinal tuberculosis is approximately 2%
Risk factors	compromised immune systems, the elderly, diabetics smokers, alcohol users, overcrowded settings, and HIV.
Imaging Findings	**X-ray:** **-**In the early stages, the intervertebral spaces appear normal -In the later stages, changes such as intervertebral space collapse, vertebral body destruction, and kyphotic deformity become evident. **-CT:** Bone destruction, sclerosis, and paravertebral masses are observed, along with soft tissue calcification and the formation of sequestra. **MRI:** -T1WI: low signal on Tl-weighted imaging (TlWI) -T2WI: high signal on T2-weighted imaging (T2WI) **PET-CT:** - Localized osteolytic bone destruction at the upper and lower margins of the adjacent vertebral bodies, along with disc destruction, is observed, accompanied by the formation of paravertebral abscesses with cold-like features. -No typical disc infiltration is noted. - Around the osteolytic lesions within the vertebral body, there is a high-density ossification reaction (sclerosis)
Treatment	**-**Medical treatment -Surgical treatment is indicated in cases with neurological complications and spinal instability
Prognosis	-The prognosis of single vertebra tuberculosis is similar to typical spinal tuberculosis. The prognosis is excellent after the appropriate therapeutic intervention. Although rare, single-vertebral tuberculosis can cause serious complications in advanced stages, such as impaired neurological function, kyphotic deformity, and spinal instability.

*****Include all cases of atypical TB

Table 2: Differential diagnosis table of single vertebral tuberculosis

Diagnosis	Commonest Location	Imaging findings	Specific features
Single-vertebral tuberculosis	**- Thoracolumbar spine**	**X-ray:** **-** In the early stages, the intervertebral spaces appear normal. - in the later stages, changes such as intervertebral space collapse, vertebral body destruction, and kyphotic deformity become evident. **CT:** **-** Bone destruction, sclerosis, and paravertebral masses are observed, along with soft tissue calcification and the formation of sequestra. **MRI:** **-** T1WI: low signal on T1-weighted imaging (T1WI). - T2WI: high signal on T2-weighted imaging (T2WI). **PET-CT:** **-** Localized osteolytic bone destruction at the upper and lower margins of the adjacent vertebral bodies, along with disc destruction, is observed, accompanied by the formation of paravertebral abscesses with cold-like features. - No typical disc infiltration is noted. - Around the osteolytic lesions within the vertebral body, there is a high-density ossification reaction (sclerosis).	**-**Involvement of posterior vertebral elements. - soft tissue calcification
Metastatic	**- Thoracic spine**	**CT** □ - revealed unremarkable cortical destruction of the affected vertebral body. - relatively homogeneous bone density, a relatively limited scope of the lesion. - the absence of surrounding soft tissue clumps. **MRI**□ **-** low signal on both T1W and T2W on MRI as well as on enhancement sweep images.	No specific imaging features

Osteoporotic fracture	**- Thoracic spine**	**CT:** **- I**rregular density increases within the vertebral body, with fracture lines appearing as linear or irregular low-density areas. - These images may also show vertebral body disruption and posterior convexity, along with the invasion of the spinal canal. **MRI:** - fractures are characterized by low signal intensity on both T1 and T2-weighted images, reflecting the fracture lines or trabecular impaction	No specific imaging features
plasmacytoma	**-Thoracolumbar spine**	**MRI** **-** the tumor shows a low signal on T1WI and a high signal on T2WI.	"mini-brain" presentation
eosinophilic granuloma	**Thoracic spine**	**CT:** - Lucent lytic lesion, with bone destruction. - Vertebra plana. **MRI:** **-** Non-specific appearance, with low T1 and high T2 signal. - Diffuse enhancement.	Langhans' giant cell infiltration
lymphoma	**Thoracic spine**	**MRI** - identify bone marrow infiltration and epidural soft tissue masses. - high signal on T2-weighted imaging (TIWI), T2-weighted imaging (T2WI) (often mildly hypointense), with homogeneous enhancement.	"ivory" vertebra

KEYWORDS

Spinal tuberculosis; Atypical spinal tuberculosis; Tuberculosis; Osteolytic lumbar tuberculosis; Singal vertebral tuberculosis; Differential diagnosis; Atypical imaging feature

ABBREVIATIONS

CT = COMPUTED TOMOGRAPHY
MRI = MAGNETIC RESONANCE IMAGING
PET = POSITRON EMISSION TOMOGRAPHY
VAS = VISUAL ANALOG SCALE
TB = TUBERCULOSIS
WBC = WHITE BLOOD CELL COUNT
CRP = C-REACTIVE PROTEIN
MON = MONOCYTE COUNT
CRP = THE C-REACTIVE PROTEIN
SINS = SPINAL INSTABILITY NEOPLASTIC SCORE
PAS = PERIODIC ACID SCHIFF
ESR = ERYTHROCYTE SEDIMENTATION RATE
SPOT = T-CELL SPOT ASSAY
IL-6 = INTERLEUKIN-6
GATA = GRADING AND ASSESSMENT OF TUBERCULOSIS OF THE SPINE
HIV = HUMAN IMMUNODEFICIENCY VIRUS
T1WI = T1-WEIGHTED IMAGING
T2WI = T2-WEIGHTED IMAGING
PET/CT = POSITRON EMISSION TOMOGRAPHY
STIR = SHORT-TAU INVERSION RECOVERY
PCR = POLYMERASE CHAIN REACTION
FDG = FLUDEOXYGLUCOSE

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