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Missed Opportunities for Diagnosing Vertebral Osteomyelitis Caused by Influential Cognitive Biases

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
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Patient: **Male, 83-year-old**
Final Diagnosis: **Vertebral osteomyelitis**
Symptoms: **Back pain • fever**
Medication: —
Clinical Procedure: —
Specialty: **Infectious Diseases**

Objective: **Mistake in diagnosis**

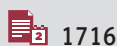
Background: Vertebral osteomyelitis is a rare form of bone infection that requires prompt diagnosis and treatment; however, this is challenging because of the lack of specific symptoms and low sensitivity of diagnostic tests, especially in the early stages. Our case demonstrates the challenges in diagnosing vertebral osteomyelitis and provides relevant information for other physicians dealing with possible cases of vertebral osteomyelitis.

Case Report: An 83-year-old man presented to the Emergency Department with severe low back pain of 2 weeks' duration. He had experienced occasional pain for several years, which was diagnosed as a compression fracture by an orthopedic surgeon at a local clinic. On arrival, he had a high-grade fever (40.2°C). The initial diagnosis was urinary tract infection, based on urinalysis results. However, after admission, vertebral osteomyelitis was diagnosed based on the results of magnetic resonance imaging of the spine and blood and urine cultures (both yielded methicillin-sensitive *Staphylococcus aureus*). He was immediately treated with the appropriate antibiotics and discharged on the 92nd day of admission without complications.

Conclusions: Our report highlights the difficulties in clinical diagnosis of vertebral osteomyelitis and identifies factors that can affect the diagnosis, including clinician bias, search satisficing, premature closure, anchoring bias, and diagnostic momentum. All patients with low back pain should be considered potential candidates for vertebral osteomyelitis.

Keywords: **Back Pain • Bone Diseases, Infectious • Diagnosis • Magnetic Resonance Imaging • Osteomyelitis • Spine**

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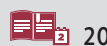
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Background

Vertebral osteomyelitis is one of the rare forms of bone infection [1]. Despite the fact that prompt diagnosis and treatment are crucial for good prognosis, it is challenging to diagnose this infection in its early stages because of the lack of specific symptoms and low sensitivity of diagnostic tests [1-4]. Our case demonstrates the challenges in diagnosing vertebral osteomyelitis and provides relevant information for other physicians dealing with possible cases of vertebral osteomyelitis. We also noted several types of clinician biases that likely delayed the diagnosis in our patient.

Case Report

An 83-year-old man presented with a complaint of severe low back pain for 2 weeks and occasional pain for several years. The patient had consulted an orthopedic surgeon at a local clinic who identified spinal compression fractures through radiographic examination. Painkillers prescribed were ineffective, and being unable to walk, the patient was transported to our hospital by ambulance. Emergency medical service staff recorded a fever of 37.7°C. The patient had a history of left hepatic lobectomy for hepatocellular carcinoma due to hepatitis B in the past.

On examination, the patient had a temperature of 40.2°C, blood pressure of 119/92 mmHg, heart rate of 117 beats per min, respiratory rate of 28 breaths per min, and oxygen saturation of 91% on room air. Lumbar spine tenderness was present over the L3 and L4 spinous processes. Although he did not show residual focal neurological symptoms, such as paralysis and aphasia, he could not walk because of severe back pain and the high fever. His white blood cell count (WBC) was 20 900/ μ L, the C-reactive protein level was 28.9 mg/dL, and urine tests detected bacteriuria and pyuria (20-29 WBC/high power field). Radiographic findings of the lumbar spine showed only compression fracture. Plain computed tomography (CT) scan revealed L1 and L3 compression fractures. Upper urinary tract infection (UTI) was suspected, based on urinalysis results. The emergency physician considered the low back pain to have little relationship with the fever because it was a long-standing symptom, which was previously diagnosed as compression fractures. Although there was no evidence of urinary tract infection on radiological imaging findings, the patient strongly believed in the positive urinalysis results and did not question it.

Meropenem (3000 mg/day) was initiated empirically. The radiogram interpretation report revealed disproportionate fat stranding around the L4/5 vertebral disk, suggesting vertebral osteomyelitis, and showed no abscess. The emergency physician could not find any abnormalities in the vertebral



Figure 1. Sagittal magnetic resonance imaging, short T1 inversion recovery sequence, demonstrates hyperintensity within the disk of L4/5 (arrow) and L4 vertebral body (arrowhead).

disk. Subsequent magnetic resonance imaging (MRI) of the spine, which was performed on the 4th day of admission, revealed the following: high signal intensity within the disks of L4/5 and L4 and L5 vertebral bodies on T2-weighted and short T1 inversion recovery sequences, suggesting edema and inflammation (Figure 1), and bilateral fluid retention in the psoas muscles and retroperitoneal space, suggesting abscesses (Figure 2). Blood and urine cultures yielded methicillin-sensitive *Staphylococcus aureus* (MSSA). Due to the evidence of inflammatory phlegmon on MRI findings, the patient was diagnosed with vertebral osteomyelitis and bilateral psoas and retroperitoneal abscesses.

We changed the antibiotics to cefazolin (5000 mg/day) based on culture sensitivity results. Transthoracic echocardiography, performed on the 12th day of admission, revealed no evidence of vegetation. Antibiotic treatment continued for 12 weeks;

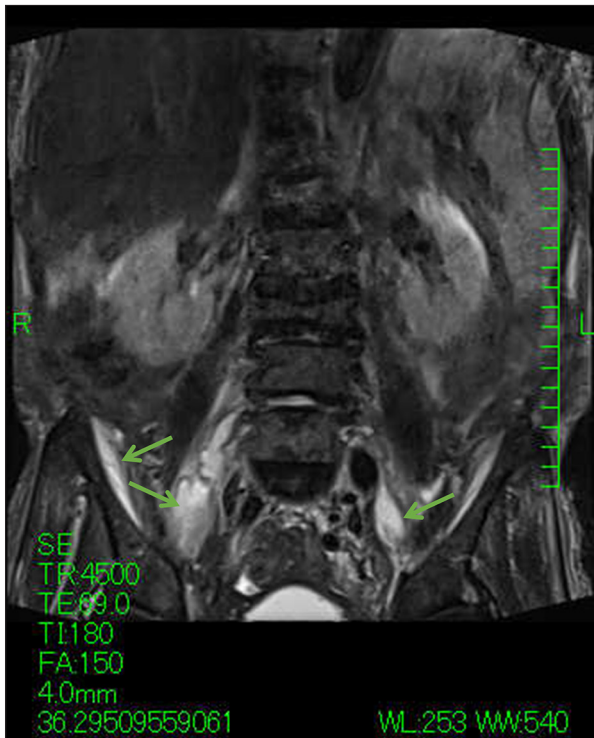


Figure 2. Coronal magnetic resonance imaging, short T1 inversion recovery sequence, demonstrates bilateral fluid retention in the psoas muscles and retroperitoneal space, suggesting abscesses (arrows).

intravenous (i.v.) antibiotics were given for 5 weeks, followed by oral therapy for 7 weeks. The patient's symptoms improved over time. Serial MRI studies confirmed regression of abscesses and complete resolution by the 89th day of admission. At this point, his symptoms, including fever and back pain, had improved sufficiently, and inflammatory markers, including the C-reactive protein levels, had become normal; therefore, we discontinued the treatment. He was originally frail, and hospitalization for >1 month (5-week i.v. antibiotic treatment) had reduced his activity more than before. He could not be discharged immediately after being treated with oral antibiotics. He needed rehabilitation, but there are only a limited number of places in Japan where he could undergo rehabilitation while continuing his treatment. Therefore, he continued to be hospitalized after completion of the i.v. treatment. However, we did not think that the duration of i.v. antibiotic treatment was too long. He was elderly and had abscesses in addition to vertebral osteomyelitis, which was difficult to drain, and sufficient duration of antibiotic treatment was required.

Oral antibiotic therapy was completed, and the patient was discharged on the 92nd day of admission. Recurrent infection was not evident at the 3-month follow-up visit.

Discussion

Recently, the incidence of vertebral osteomyelitis has been increasing owing to the growing elderly population. The annual incidence of vertebral osteomyelitis in the United States between 1998 and 2013 increased from 2.9 to 5.4 per 100 000 [1]. Back pain is the typical presenting symptom (86%), whereas fever is occasional (35-60%) [2-4]. In some cases, painkillers might mask the fever and contribute to delayed diagnosis; however, there is a lack of consensus regarding this issue. A previous report suggested that the frequency of the presenting fever was inconsistent and depended on the use of painkillers; others argued that advanced age, antecedent low back pain, and painkiller intake contribute to delayed diagnosis [5,6].

The clinical diagnosis of vertebral osteomyelitis is challenging; a long duration from the onset of symptoms to admission (average, 48±40 days) and very high incidence of initial misdiagnosis (80%) have been reported [7]. The lack of specific symptoms and low sensitivity of diagnostic tests seem to be associated with these diagnostic delays and misdiagnoses. Radiographic and CT examinations do not have enough sensitivity to detect vertebral osteomyelitis (radiography, 14-54%; CT, 67%), especially early in the course of the disease [8,9]. However, as observed in this case, paravertebral fat stranding on CT can be a key incidental finding for suspecting vertebral osteomyelitis in patients suspected to have other diseases [10]. Combined with fever and back pain, paravertebral stranding can be a good indication for MRI, the most sensitive and specific method for the diagnosis of vertebral osteomyelitis. Regarding blood cultures, although the sensitivity is average (approximately 50%), a positive blood culture can play a key role in diagnosis [2-4].

CT-guided percutaneous biopsy, one of the most important diagnostic tests of vertebral osteomyelitis, is often indicated for the isolation of causative microorganisms [11,12]. This is one of the reasons the rate of positive blood cultures, which varies from 40% to 89%, is not so high [13]. However, we did not perform CT-guided percutaneous biopsy because the causative micro-organism had already been identified through blood culture. Additionally, clinical and radiographic findings typical of pyogenic vertebral osteomyelitis were observed in this case. Further, the patient was old, and invasive testing was unsuitable. Otherwise, biopsy should be actively performed despite the patient having recently received antibiotics.

Vertebral osteomyelitis, psoas, and retroperitoneal abscesses are interrelated and share the same risk factors; they can each result from either a local, contiguous source or from hematogenous dissemination. Each of these conditions can result in any of the others [14]. Among these, psoas abscess due to vertebral osteomyelitis is the most frequently reported [14,15].

In this case, there are 2 possibilities regarding the pathogenesis: first, the UTI and abscesses occurred secondary to vertebral osteomyelitis; second, *S. aureus* bacteriuria resulted from *S. aureus* bacteremia due to vertebral osteomyelitis. We did not consider that UTI was the primary focus of infection because MSSA as a causative organism of community-acquired UTI is rare [16]. Even in the absence of a UTI, *S. aureus* bacteremia is frequently (8-34%) accompanied by bacteriuria and can indicate *S. aureus* bacteremia with a focus of infection in the vertebral column [16,17].

Additionally, several types of clinician biases likely delayed the diagnosis: We stopped performing further assessments once we had identified compression fractures and UTI, without evaluating other causes of low back pain. Moreover, it was premature to diagnose UTI despite there being no symptoms of UTI and no evidence of UTI on radiological imaging. Considering that the patient had several of the “red flags” of low back pain, such as advanced age (>50 years), failure to improve with treatment, and signs of infection (fever) [18], vertebral osteomyelitis should have been considered as a differential diagnosis at the time of the patient’s visit to the Emergency Department. In our case, it was not considered because compression fractures and UTI seemed to explain the low back pain and fever. Despite suspicion that vertebral osteomyelitis was improbable in this case since vertebral osteomyelitis following osteoporotic vertebral fracture is reported to be very rare [19], physicians should consider that a working diagnosis of UTI may be an indicator to continue diagnostic workup. A previous study reported that UTI was the most common initial misdiagnosis in patients with vertebral osteomyelitis [7]. Pyuria, despite being considered evidence of UTI, is not always an accurate diagnostic marker for it. A study reported that the sensitivity and specificity rates of pyuria in UTI screening were 62% to 98% and 55% to 96%, respectively [20].

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Vertebral osteomyelitis is relatively rare, whereas compression fractures and UTIs are often encountered in patients in the Emergency Department. We made a typical, frequently encountered, less severe diagnosis.

The inaccurate diagnosis was passed on to and accepted by other clinicians without its validity being questioned. In this case, this was emphasized because the initial diagnosis was made by an orthopedic surgeon. In this case, the delay in diagnosis was only a few days and might not have contributed much to the lengthening of the hospitalization duration. What we would like to emphasize is that such common mistakes have an impact on further diagnosis and treatment. Even a delay of few days could make a big difference for frail elderly patients.

Conclusions

This case demonstrated the challenges faced in diagnosing vertebral osteomyelitis. Initial misdiagnosis is common, and physicians should consider all low back pain patients with symptoms of infection, such as fever and increased inflammatory markers, as potential candidates for vertebral osteomyelitis. A previous diagnosis is sometimes misleading; thus, the cause of the patient’s symptoms should be reassessed in detail.

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Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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