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Original Research

Clinical and Radiological Predictors of Positive Microbiological Yield in Vertebral Osteomyelitis: A Retrospective Cohort Study

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ABSTRACT

Objective: To evaluate demographic, laboratory, biopsy, and imaging variables as potential predictors of microbial identification in patients with suspected vertebral osteomyelitis, aiming to enhance diagnostic accuracy and optimize patient care.

Methods: This retrospective cohort study analyzed 83 patients who underwent image-guided percutaneous disc-space sampling between June 2020 and December 2023. Inclusion criteria were adults aged ≥18 years with imaging-based evidence of vertebral osteomyelitis and clinical suspicion of infection. Exclusion criteria were presence of known malignancy and non-infective causes. Demographics, clinical history, imaging, biopsy, and microbiology data were collected. Logistic regression analysis was used to identify predictors of positive microbiological yield.

Results: Microorganisms were identified in 32 of 83 cases (38.6%), with *Mycobacterium tuberculosis* being the most common pathogen identified (21.9%). Elevated C-reactive protein (CRP) levels, erythrocyte sedimentation rate (ESR), and paravertebral signal changes on MRI were associated with a positive culture yield. Multivariate analysis identified CRP as an independent predictor of positive microbiological results. CT-guided percutaneous biopsy was found to be safe, with no major complications reported.

Conclusion: CT-guided percutaneous biopsy is a reliable and safe diagnostic tool for identifying the causative pathogens in vertebral osteomyelitis. Elevated CRP levels were independently associated with positive microbiological yield, highlighting its role as a crucial predictor in clinical practice. These findings underscore the importance of incorporating CRP levels into the diagnostic process, potentially guiding the selection of patients for biopsy to improve the detection of infection.

Keywords: biopsy; discitis; osteomyelitis; vertebra; spinal infection.

INTRODUCTION

Vertebral osteomyelitis with secondary discitis predominantly affects older men and accounts for a significant proportion (3-5%) of bone infections [1]. Although spondylodiscitis refers to intervertebral disc infections and vertebral osteomyelitis is associated with vertebral body invasion, the terms are often

used interchangeably due to their concurrent manifestation [2]. The incidence, estimated at approximately 2.4 cases per 100,000 individuals, rises with age and can be attributed to factors such as an aging population, an increase in immunocompromised states and intravenous drug usage. Left untreated, the condition can lead to severe complications, including spinal deformity, canal narrowing, paralysis, and a notable death rate of 2%-11% [3-5].

Diagnosing and managing vertebral osteomyelitis poses significant challenges due to the presence of nonspecific symptoms, often resulting in delayed diagnosis and worse clinical outcomes, including extended neurological deficits [4, 6]. Diagnosis involves a comprehensive approach that integrates clinical examination, laboratory tests, and imaging modalities. Although the laboratory tests, which may show the presence of elevated inflammatory markers, can aid in diagnosis, their specificity is limited, underscoring the need for improved diagnostic strategies [4, 7]. Additionally, blood cultures are positive in only 40-60% of the patients [8].

Contrast-enhanced magnetic resonance imaging (MRI) has emerged as the preferred imaging modality due to its high sensitivity in detecting discitis, although challenges remain, particularly in differentiating infectious from non-infectious conditions [4, 7, 9-12]. When clinical suspicion persists despite negative blood cultures, a direct biopsy is often carried out to confirm the presence of infection; yet, its variable sensitivity (31-91%) necessitates the identification of predictive factors to optimize culture yield [13-15].

Main Points

- CT-guided percutaneous biopsy is a safe diagnostic tool for vertebral osteomyelitis.
- Elevated CRP levels serve as a significant independent predictor of positive microbiological yield.
- MRI-based paravertebral signal changes correlate with higher culture positivity rates.
- Mycobacterium tuberculosis is the most commonly identified pathogen, stressing the need for routine TB cultures in endemic regions.

The current study aimed to comprehensively evaluate demographic, laboratory, biopsy, and imaging variables as potential predictors of microbial detection in specimens from patients with suspected vertebral osteomyelitis, with the aim of improving diagnostic accuracy and patient care through consolidated and validated results.

MATERIALS AND METHODS

A retrospective cohort study was conducted on patients who underwent image-guided percutaneous disc-space sampling for suspected vertebral discitis and/or osteomyelitis between June 2020 and December 2023, following the acquisition of ethical approval.

The inclusion criteria consisted of patients aged 18 years or older with imaging-based evidence of vertebral osteomyelitis, the presence of edema and contrast enhancement of the intervertebral disc, vertebrae, or paravertebral soft tissues. Additional criteria were the presence of an abscess or facet joint effusion, along with clinical suspicion of osteomyelitis as evidenced by manifestations such as back pain, fever, and/or neurological deficits. Exclusion criteria comprised of known or established malignancy and other non-infective causes (e.g., reactive osteitis) with clinical or radiological features. Cases where imaging results were indeterminate for infection or where neoplasm was a major consideration, as well as cases with incomplete procedural notes, pathology reports, or clinical records, were excluded. Additionally, cases where the biopsy was prematurely terminated or led to no specimen submission, and cases where the final pathology indicated the presence of noninfectious mass lesions, were also excluded. Based on these criteria, only one patient out of the 84 initially recruited was excluded due to the presence of diffuse B-cell lymphoma, resulting in the inclusion of 83 patients in the study.

All relevant patient data, including baseline demographic information, clinical history, histopathology, and microbiology data, were retrieved from the hospital's electronic medical record system. Imaging data were reviewed on the Radiology Department's electronic Picture Archiving and Communication System (PACS) by a musculoskeletal interventional radiologist, who was blinded to microbiological or histological results. The pre-procedural MRI for all patients was reviewed, with the radiologist noting specific imaging features such as disc hyperintensity, the presence of paraspinal or paravertebral abscess or fluid, epidural abscess, paravertebral signal changes,

vertebral endplate signal changes, disc height reduction, disc degeneration, and narrowing of the disc space.

Data retrieved from the databases included patient age, sex, procedure level, specimen culture/staining result, presence or absence of prior antibiotic treatment, procedural details, needle size, and blood cultures, as well as pre-procedural CRP, ESR, and WBC levels. The history of antibiotic usage was obtained from multiple sources, including patient-reported use of medications at home, documentation from outside hospital transfers, infectious diseases consultation notes, and inpatient pharmacy records. Patients with any intravenous antibiotic exposure 6 weeks prior to undergoing disc aspiration were considered positive for antecedent antibiotic therapy [1].

All biopsies were carried out by the same interventional radiologist with 8 years of experience, under local anesthesia and CT guidance. The CT-guided biopsy was carried out on a Somatom Definition AS plus (Philips, Netherlands), with thin-slice planning CT scans obtained in the prone position, and multiplanar reconstructions that were used for non-traumatic biopsy needle positioning. Abscess samples were collected with a Chiba® needle (18G). For the discal space, a Geotek® needle (11G, 13G or 16G) was used (Figures 1, 2).

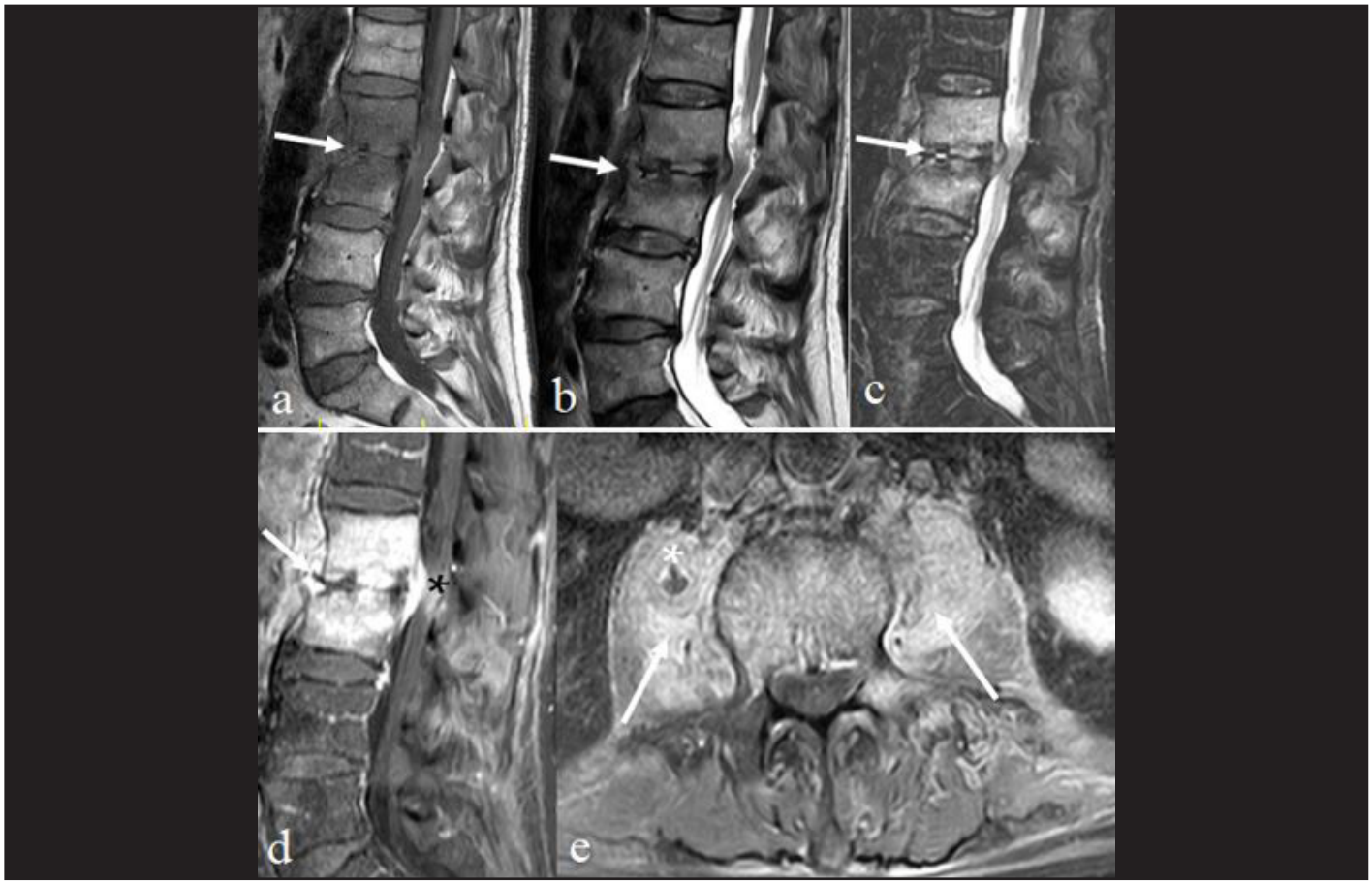

Figure 1. A 46-year-old male patient presented with severe back pain and fever. The patient had a 3-week history of fevers and increasing back pain. In the sagittal T1-weighted (A), T2-weighted (B), and STIR (C), fat-suppressed T1 gadolinium-enhanced (D) MR images of the thoracic spine, loss of height and increased T2 signal intensity and enhancement of the L2-3 disk are observed (white arrow). Cortical erosions with low T1 signal intensity, high T2 signal intensity, enhancement of adjacent endplates, and essentially the entirety of each vertebral body are evident. Additionally, there is high T2 signal intensity and enhancing anterior and posterior paravertebral soft tissue centered at this level, which is a concern for discitis-osteomyelitis. An anterior epidural abscess (black asterisk) spans L2-3. In the axial T1-weighted fat-suppressed gadolinium-enhanced MR image of the thoracic spine, marked enhancement of the L3 vertebral body and overlying anterior paravertebral soft tissues (white abscess) and a right paraspinal abscess (white asterisk) are visible.

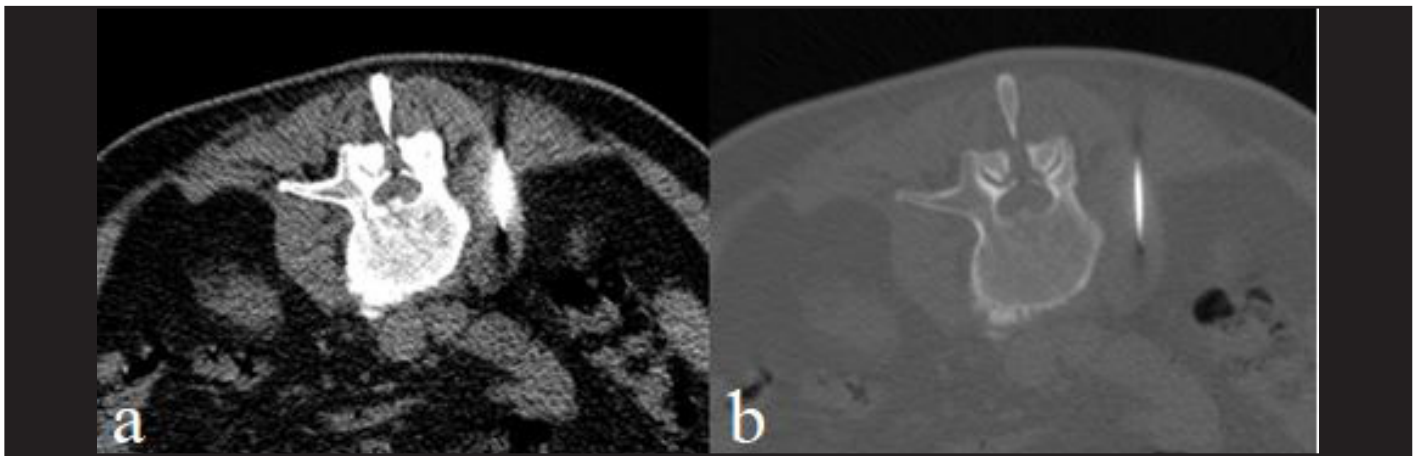

Figure 2. A: The sample (same patient as Figure 1) is depicted in the soft tissue window. B: The sample shows the bone window. An axial unenhanced CT image, taken with the patient in the prone position during percutaneous biopsy, reveals the needle (white arrow) in the paravertebral soft tissues adjacent to the L3 vertebral body. The pathology report noted the presence of acute and chronic osteomyelitis. Cultures from the biopsy showed the presence of *Staphylococcus aureus* infection.

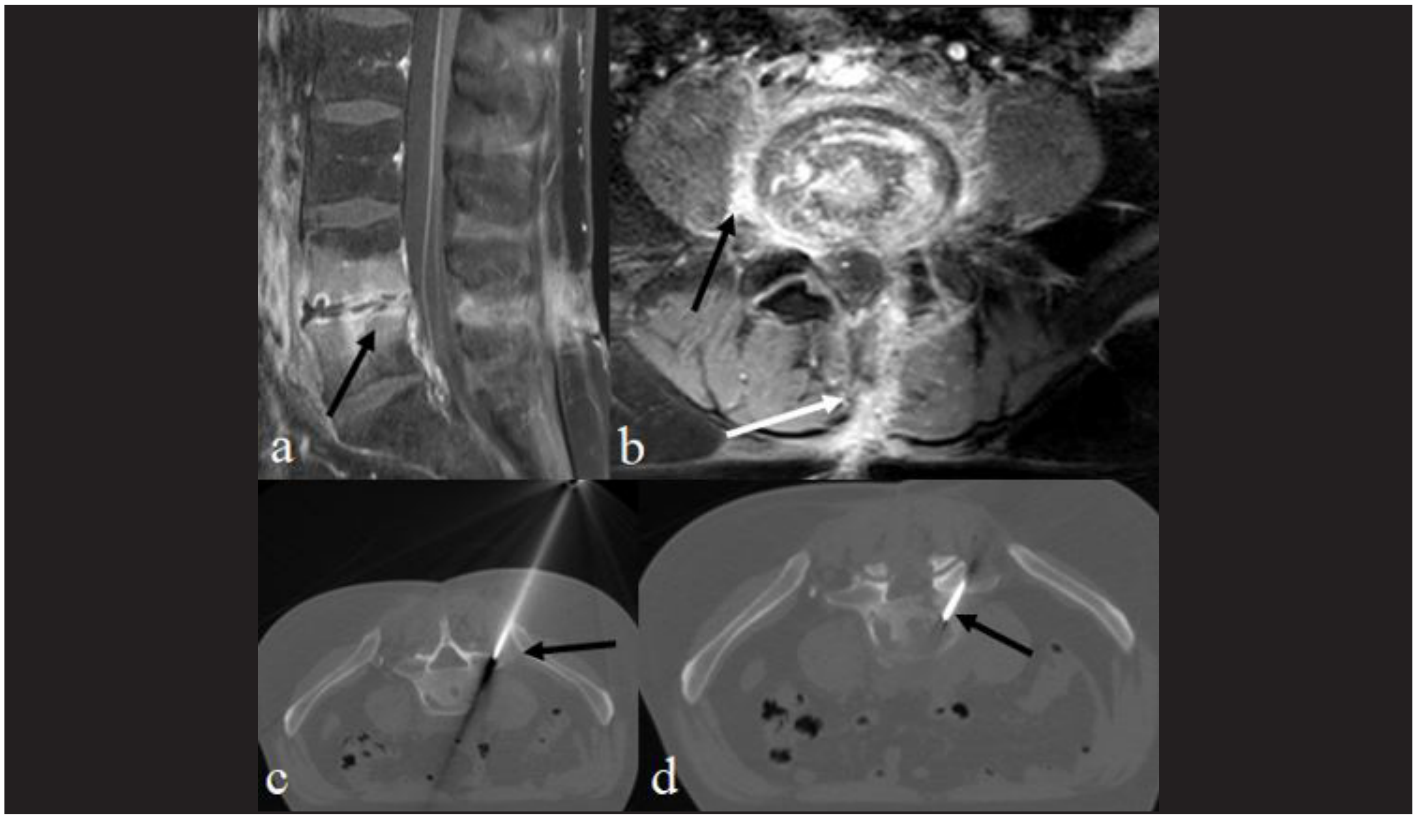

Figure 3. A 75-year-old male patient with a history of severe back pain for three months. A: Sagittal post-contrast lumbar spine image shows loss of the L4-5 intervertebral disk, erosions of adjacent endplates, narrowing in the intervertebral disk space, and contrast enhancement of vertebral bone (black arrow). B: Post-contrast axial image reveals paravertebral signal changes, contrast enhancement (black arrow), and a fistulation tract to the dermal area (white arrow), which is a concern for discitis-osteomyelitis. C and D: Axial unenhanced CT images with the patient in the prone position during percutaneous biopsy, taken 6 days after A, show a biopsy needle in the L4-5 intervertebral disk (black arrow). The pathology report noted fragments of fibrocollagenous tissue and acute and chronic inflammation. Cultures from the biopsy showed the presence of Viridans Group Streptococci**.**

The microbiological evaluation of the samples included in the study was performed by a microbiology specialist. Materials such as abscess, tissue/biopsy taken from patients during the procedure were placed in a sterile container and peripheral venous blood samples were sent to the microbiology laboratory in blood culture bottles. Abscess and tissue/biopsy samples were microscopically examined by Gram staining and inoculated onto sheep blood agar, eosin-methylene agar and chocolate agar. Blood culture samples were placed in the blood culture unit and, if the signal was positive, the bottles were microscopically examined by Gram staining and inoculated onto appropriate media. Microorganisms growing in samples incubated for 2-3 days under appropriate environmental conditions were identified by matrix-assisted laser desorption/ionization-time of flight mass spectrometry (MALDI-TOF Microflex LT/SH Smart MS, Bruker Daltonics).

Molecular rapid diagnostic tests have been used for *Mycobacterium tuberculosis*. The BD MAX MDR-TB assay is an automated, qualitative molecular assay for the direct detection of *M. tuberculosis* DNA from clinical specimens and was used in this study for abscess, tissue/biopsy specimens. Solid samples, such as tissue/biopsy samples, are cut into small pieces in a sterile mortar. Approximately 2 mL of sterile phosphate buffered saline is added to the abscess, tissue/biopsy sample. The sample and PBS solution were mixed until a homogeneous suspension was obtained. One ml of the prepared sample was mixed with 2 ml of BD Sample Processing Reagent. Further steps, according to the manufacturer's instructions, took approximately 30 minutes, and the samples were loaded into the instrument. The BD MAX multiplex PCR platform automatically performed DNA extraction, target PCR amplification, detection, and result interpretation.

The data were analyzed with SPSS software (version 23, IBM, Armonk, NY, USA). The normal distribution of all quantitative variables was assessed using the Shapiro–Wilk test, with normalizing transformations carried out as necessary. Data were expressed as mean ± standard deviation (SD) unless otherwise stated. Two-group comparisons utilized Student's t test for continuous variables or the chi-squared test for categorical variables. Logistic regression analysis was carried out to determine univariable predictors of positive microbial yield, with predictors having $P < 0.1$ included in a multivariable model to identify independent predictors of yield. P-values less than 0.05 were considered as statistically significant**.**

RESULTS

A total of 83 vertebral biopsies conducted on 83 patients over a period of 3 years were included in the study. All patients underwent MR imaging prior to the biopsy. The mean age of the patients was 57.63 ± 17.03 years (range: 16 to 86 years) and 36 were male. Table 1 shows detailed demographics and baseline characteristics. Eleven patients (13.2%) presented with fever, while two patients (2.4%) experienced acute paraparesis. The predominant symptom observed among the majority of patients was back pain, accounting for 84.3% of the cases.

The 83 biopsies were conducted on 83 individual patients, with no instances of repeat biopsies at our center. All 83 biopsies (100%) were successfully carried out without any complications. Notably, there were no instances of major or minor hemorrhage, infection, fistula formation, or pneumothorax associated with the biopsies. Core biopsy procedures were carried out in 74 (89.1%) patients and aspiration biopsy was carried out in 9 (10.9%) patients. Microorganisms were detected by PCR or culture in 32 cases (38.6%). *Mycobacterium tuberculosis* was the most common microorganism, accounting for 21.9% of the cases, followed by *Staphylococcus aureus* (18.8%) and viridans group Streptococci (15.6%) (Table 2).

In our patient cohort, 34 individuals (41%) had received antibiotic therapy prior to biopsy. Remarkably, microbiological findings from the biopsy significantly impacted antibiotic management in 43 cases (51.8%). For instance, microbial detection results led to changes in antibiotic therapy in line with the antibiotic susceptibility profiles obtained. In addition, in cases where empiric antibiotic treatment was initiated, microbiological identification results and antibiotic susceptibility, if any, influenced subsequent treatment protocols.

Our study also showed that in 8 out of 32 cases (25%) where microorganisms were detected, there was a match between the organisms identified in blood cultures and those isolated from biopsy samples. In four cases within our cohort, patients required surgery due to negative biopsy results. Post-surgery, two patients were diagnosed with *M. tuberculosis*, one with *Staphylococcus aureus*, and one with *Actinomyces* spp., leading to a revision of their treatment plans based on surgical findings. The pathology results and biopsy procedural details are summarized in Table 3. Of the total biopsies performed, 18 (21.7%) were thoracic, 65 (78.3%) were lumbar, and none were cervical. Biopsy locations ranged from T4-5 to T12 and L1-S1, with varying frequencies

and percentages across different levels. For example, the most common biopsy location was L4-5, accounting for 25.3% of all biopsies, followed by L3-4 (14.5%) and L5-S1 (13.3%).

The biopsy locations included the disc, paraspinal paravertebral fluid, vertebra endplate, and paravertebral soft tissue. Disc biopsy was the most prevalent (49.4%), followed by vertebra endplate (34.9%) and paraspinal paravertebral fluid (10.8%). The different techniques used for biopsies included transpedicular, trans costovertebral, posterior, and posterolateral with transpedicular being the most common (59%). Needle sizes varied, with 74.7% of biopsies using a needle size of 11. Needle sizes 18 and 13 accounted for 10.9%, and size 16 for 3.6% of the biopsies.

Pathology results included the presence of inflammation, spondylodiscitis osteomyelitis, granulomatous lesions, and fungal pathogens along with non-specific findings. Non-specific findings were the most common pathology result, accounting for 49.4% of all biopsies, followed by inflammation (37.3%) and spondylodiscitis osteomyelitis (9.6%). Patient characteristics and technical details regarding a positive microbiological yield are delineated in Table 1. CRP (p=0.003), sedimentation rate (p=0.027), and paravertebral signal changes (p=0.049) were significantly associated with a positive culture yield.

Univariate and multivariate analysis results are presented in Table 4. Univariate regression analysis was performed to identify independent variables that may have an impact on the results of microbial detection. We identified that a one-unit increase in the CRP value increased the probability of a positive result by 1.02 times (95% CI: 1.004-1.039; p=0.014). All variables examined in univariate analysis and with a p value below 0.1 were included in a multivariate logistic regression using the backward logistic regression method. The multivariate analysis indicated that a one-unit increase in CRP increased the probability of a positive microbiological result by 1.01 times (95% CI: 1.003-1.036; p=0.021). The Nagelkerke R Square value for the multivariate model was 0.168. Other variables, such as age, gender, biopsy level, presence of disc hypersensitivity, presence of paraspinal or epidural abscesses, paravertebral signal changes, endplate signal changes, disc thinning, sedimentation rate, white blood cell count and antibiotic use did not show statistically significant associations with a positive microbiology result in either univariate or multivariate analyses.

Table 1. Biopsy characteristics associated with a positive microbiological yield.

	Microorganism detection		
	Negative (n=51)	**Positive (n=32)**	**p**
Age/mean±SD	59.11±14.19	58.68±16.39	0,900[a]
CRP/median (IQR)	6.80 (2.60-21.40)	23.55 (9.55-53.77)	**0.003**[b]
ESR/median (IQR)	23.00 (13.00-43.00)	38.00 (22.00-60.50)	**0.027**[b]
WBC/median (IQR)	7.34 (5.90-9.92)	7.89 (6.60-9.20)	0.674[c]
	n (%)	**n (%)**	
Biopsy level			
Thoracic	8 (15.7)	10 (31.2)	0.081[c]
Lumbar	43 (84.3)	22 (68.8)	
Sex			
Female	29 (56.9)	18 (56.3)	0.956[c]
Male	22 (43.1)	14 (43.8)	
Biopsy localization			
Disc			
Yes	45 (88.2)	24 (75.0)	0.117[c]
No	6 (11.8)	8 (25.0)	

Paraspinal paravertebral fluid			
Yes	4 (7.8)	6 (18.8)	0.128 [c]
No	47 (92.2)	26 (81.3)	
Vertebra endplate			
Yes	21 (41.2)	15 (46.9)	0.610 [c]
No	30 (58.8)	17 (53.1)	
Paravertebral soft tissue			
Yes	3 (5.9)	4 (12.5)	0.254 [c]
No	48 (94.1)	28 (87.5)	
Biopsy types			
Tru-cut	48 (94.1)	26 (81.3)	0.072 [c]
Aspiration	3 (5.9)	6 (18.8)	
MRI findings			
Discitis, hyperintensity in the disk			
Yes	40 (78.4)	28 (87.5)	0.296 [c]
No	11 (21.6)	4 (12.5)	
Paraspinal paravertebral abscess-fluid			
Yes	17 (33.3)	17 (53.1)	0.074 [c]
No	34 (66.7)	15 (46.9)	
Epidural abscess			
Yes	3 (5.9)	2 (6.3)	0.644 [c]
No	48 (94.1)	30 (93.8)	
Paravertebral signal changes			
Yes	19 (37.3)	19 (59.4)	**0.049** [c]
No	32 (62.7)	13 (40.6)	
Vertebral endplate signal changes and irregularities			
Yes	45 (88.2)	25 (78.1)	0.217 [c]
No	6 (11.8)	7 (21.9)	
Disk thinning, disc degeneration or narrowing of the disc space			
Yes	24 (47.1)	17 (53.1)	0.591 [c]
No	27 (52.9)	15 (46.9)	
Pre-existing antibiotic therapy			
Yes	30 (58.8)	19 (59.4)	0.960 [c]
No	21 (41.2)	13 (40.6)	

[a] Independent sample t test; [b] Mann-Whitney U test; [c] Chi square test

CRP:C reactive protein, ESR: Erythrocyte sedimentation rate, WBC: White blood cell

Table 2. Microorganisms identified from the samples included in the study

Microorganisms	**n**	**%**
Mycobacterium tuberculosis	7	21.9
Staphylococcus aureus	6	18.8
Viridans group Streptococci	5	15.6
Brucella spp.	4	12.5
Coagulase-negative staphylococci	3	9.4
Actinomyces spp.	3	9.4
Candida spp.	2	6.3
Morganella morganii	1	3.1
Bacillius mageterium	1	3.1
Total	**32**	**100**

Table 3. Technical and procedural details of the biopsies.

	Microorganisms detected n=32 (38.6%)		**No microorganism detected n=51 (61.4%)**	
Biopsy location				
0 T4-5	2	6.3%	0	
1 T6-7	1	3.1%	0	
2 T 8-9	3	9.4%	2	3.9%
3 T10-11	2	6.3%	4	7.8%
4 T12-L1	2	6.3%	1	2.0 %
5 L1	2	63%	1	2.0 %
6 L1-2	5	15.6%	4	7.8 %
7 L2-3	3	9.4%	5	9.8 %
8 L3-4	1	3.1%	11	21.6 %
9 L4-5	8	25.0%	13	25.5 %
10 L5-S1	2	6.3%	9	17.6 %
11 T9-10	1	3.1%	0	
12 T12	0		1	2%
Biopsy localization				
1 disc	12	37.5	29	56.9
2 paraspinal paravertebral fluid	6	18.8	3	5.9
3 vertebra end plate	12	37.5	17	33.3
4 paravertebral soft tissue	2	6.3	2	3.9
Technique				
1 Transpedincular	15	46.9	34	66.7
2 Transcostovertebral	5	15.6	3	5.9
3 Posterior	4	12.5	6	11.8
4 Posterolateral	8	25.0	8	15.7

Needle size				
11	20	62.5	42	82.4
13	4	12.5	5	9.8
16	2	6.3	1	2.0
18	6	18.8	3	5.9
Pathology results				
1 Non-specific	15	46.9	26	51.0
2 Inflammatory Processes	12	37.5	19	37.3
3 Spondylodiscitis Osteomyelitis	3	9.4	5	9.8
4 Granulomatous Lesions	1	3.1	1	2.0
5 Fungal Pathogens	1	3.1	0	

Table 4. Univariate and multivariate logistic regression analysis results in determining variables effective on microbiology results.

Variables	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	p	OR (95% CI)	p
Age	0.998 (0.969-1.028)	0.898		
Sex; Female (Ref: Male)	1.025 (0.420-2.501)	0.956		
Biopsy level; Thoracic (Ref: Lumbar)	2.815 (0.986-8.042)	**0.053**		
Disc hyperintensity No (Ref: Yes)	1.925 (0.556-6.666)	0.301		
Paraspinal abscess (No) (Ref: Yes)	2.267 (0.916-5.609)	**0.077**		
Epidural abscess (No) (Ref: Yes)	1.067 (0.168-6.760)	0.945		
Paravertebral signal changes (No) (Ref: Yes)	2.462 (0.995-6.088)	**0.051**	2.307 (0.893-5.963)	0.084
Endplate signal changes (Yes) (Ref: No)	2.100 (0.636-6.938)	0.224		
Thinning of disc (No) (Ref: Yes)	1.275 (0.526-3.091)	0.591		
CRP	1.021 (1.004-1.039)	**0.014**	1.019 (1.003-1.036)	0.021
ESR	1.017 (0.998-1.037)	**0.085**		
WBC	0.999 (0.998-1.000)	**0.068**		
Antibiotic (no) (Ref: yes)	1.053 (0.893-1.242)	0.539		

Nagelkerke R Square: 0.168

DISCUSSION

In this retrospective study, we investigated the diagnostic efficacy of CT-guided percutaneous biopsies and aspirates in 83 suspected cases of vertebral osteomyelitis. Our findings revealed that microorganisms were detected in 38.6% (32 patients) of the samples included in the study. At the species level, *M. tuberculosis* was the predominant microorganism (21.9%) followed by *Staphylococcus aureus* (18.8%). At the genus level, *Staphylococcus* spp. were detected in 32.3% of the positive cases, together with *Staphylococcus aureus* and coagulase-negative Staphylococci.

Several factors were found to be associated with microbial detection, including CRP levels (p=0.003), sedimentation rate (p=0.027), and paravertebral signal changes (p=0.049). However, in the multivariate analysis, only CRP levels emerged as an independent factor with a significant association with a positive microbiology result. A one-unit increase in CRP levels was associated with a 1.019 times increase in the likelihood of a positive result (p = 0.021).

The literature reports a wide range of CT-guided vertebral

biopsy yields, spanning from 31% to 91% [13, 14, 16]. Several factors may contribute to this variability in diagnostic yield. These factors include differences in the imaging modalities used for biopsy guidance (CT versus fluoroscopy), the type of causative organism (e.g., *M. tuberculosis* versus *S. aureus*), prior antimicrobial therapy administered before biopsy, needle size used for the biopsy procedure, the number of specimens obtained per patient, experience of the pathologist, and criteria utilized for histopathological diagnosis of vertebral osteomyelitis.

Moreover, inconsistencies in reference standards across different studies and the potential for bacterial contamination may lead to either overestimation or underestimation of the accuracy of percutaneous spinal biopsy results [17]. Despite efforts to address these factors, the reasons behind the comparatively lower diagnostic yield of percutaneous spinal biopsy compared to other specimen acquisition methods remain unclear [6].

Understanding the pathophysiology of vertebral osteomyelitis and spondylodiscitis may shed light on this discrepancy. Infections in adults usually start with a hematogenous spread, affecting the subchondral bone before advancing into the intervertebral discs. Ideally, samples should be taken from the subchondral bone since paravertebral abscesses and intervertebral fluid may be sterile [18]. Chronic inflammation in vertebral bodies may increase sclerosis and reduce blood supply, potentially lowering diagnostic yields even in infected osseous samples [19]. These complexities emphasize the need for further research to improve diagnostic accuracy [6].

Another significant finding in our study population is the prevalence of *M. tuberculosis* as the most frequently encountered infectious agent. This differs from pyogenic spinal osteomyelitis frequently seen in Western countries, where *Staphylococcus* is typically the primary infecting organism, accounting for over 50% of cases [11, 20-24]. We observed a much lower frequency of *Staphylococcus* infections, with only 6 cases out of the 32. One potential explanation for this variation compared to other studies is the endemic presence of *M. tuberculosis* in Türkiye and the high awareness of tuberculosis (TB).

The heightened incidence of TB in certain geographical regions, driven by socioeconomic factors, the HIV epidemic, and increasing immunosuppression, underscores the critical need to include TB-specific cultures when testing specimens. However, it is concerning that only 45% of However, it is concerning that only 45% of the studies reviewed identified *M. tuberculosis [6]*. With the recent rise in HIV and immunosuppression-associated cases of TB and the projected increase in the incidence of TB, it is imperative to consider TB during the diagnosis of vertebral osteomyelitis and ensure that TB-specific diagnostic methods are integrated into protocols. The Infectious Diseases Society of America (IDSA) recommends additional serological tests in cases suspected of atypical infections such as tuberculosis or brucellosis [25]. Suspicion for these atypical organisms may be manifested as multilevel involvement on MRI or with thoracic involvement, which is frequently observed in tuberculous discitis-osteomyelitis [21].

In this study, we observed that the inflammatory markers CRP and ESR were significantly higher in the group where microorganisms were detected, which is consistent with previous studies [6, 15, 26-29]. A logistic regression analysis identified CRP at admission as the sole independent predictor of a positive yield from CT-guided biopsy, corroborating the data by Ahuja et al. [26]. Specifically, each unit increase in CRP was associated with a 1.01-fold increase in the odds of microbial detection (95% CI: 1.002-1.036; p=0.021; Table 4). These findings underscore the significance of elevated inflammatory markers in patients with microbial infections, as it generally indicates a potentially greater disease burden or a more aggressive disease course [6].

We found that paravertebral signal changes were significantly associated with a positive yield (p=0.049) in the current study. While some studies have reported similar findings, others have suggested that increased paravertebral soft tissue thickness correlates with positive microbiological results [30, 31]. These data suggest that paravertebral soft tissue changes in cases of discitis-osteomyelitis are not merely reactive; rather, it is indicative of actual bacterial infection. Therefore, such changes are reliable targets for biopsy and are determinants of microbial detection results. Compared to endplate and disc paravertebral soft tissues often have a richer vascular supply that can potentially foster bacterial growth. This could explain the observed association between paravertebral signal changes and microbial detection.

Patients exhibiting paravertebral soft tissue changes suggestive of aggressive infections may harbor a higher pathogen burden, thereby increasing the likelihood of a positive microbiological yield from percutaneous needle biopsy. Conversely, patients without paravertebral signal changes may have less aggressive

or less advanced infections, possibly resulting in a smaller pathogen burden and may not benefit from a percutaneous needle biopsy [31]. Future prospective studies can be designed to assess the severity of infection and paravertebral soft-tissue changes at the time of biopsy and explore their correlation with microbial detection efficiency.

We observed no association between prior antibiotic usage and microbiological yield in the current study, aligning with findings from the literature [6, 16]. This underscores the importance of carrying out biopsies even in cases with prior exposure to antibiotics [29]. However, the guidance from the IDSA remains consistent, recommending the withholding of antimicrobial therapy for 1-2 weeks before biopsy to optimize microbiologic yield, unless the patient is severely ill. Yet, evidence on the impact of antecedent antimicrobial therapy on biopsy yield remains limited and controversial [11, 31-34]. A recent meta-analysis failed to demonstrate a significant difference in microbiological yield whether or not the patient was exposed to antimicrobial therapy before the biopsy [16]. Nevertheless, the interpretation of these findings poses challenges due to variations in study methodologies and definitions of antimicrobial exposure. Since the publication of the meta-analysis of McNamara, several studies have reported no disparity in microbiological yield with antecedent antimicrobial exposure [35, 36]. Despite such conflicting data, the IDSA maintains its recommendation to withhold antimicrobial therapy before biopsy to maximize yield, thus facilitating the initiation of targeted antimicrobial therapy and minimizing the need for empirical treatment.

The present study has several limitations that need to be considered. First, its retrospective design and small sample size impose inherent constraints on the robustness and generalizability of the findings. However, given the rarity of vertebral osteomyelitis, conducting a prospective study with a large patient cohort presents significant challenges. Second, antibiotic usage by the patients was assessed on the basis of medical records. The retrospective nature of the study limited our ability to ascertain the regularity and duration of antibiotic use accurately. This may have introduced variability in the results. Third, we did not collect data on the volume of the biopsy specimens, which prevents a quantitative analysis of the impact of specimen volume on diagnostic yield. Lastly, data on long-term outcomes were not collected, preventing an assessment of the durability of the treatment and patient prognosis.

CONCLUSION

In summary, CT-guided percutaneous biopsy is a safe diagnostic tool for vertebral osteomyelitis; nonetheless, isolation of the causative pathogen remained limited at 38.6%. Elevated CRP and ESR values, along with paravertebral signal changes in MRI correlated with higher rates of positive microbiology samples, with CRP serving as a significant independent predictor for microbiological yield.

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