ORIGINAL ARTICLE

Phnx Med J. July 2023, Volume 5 No 2
DOI:10.38175/phnx.1239682

Vertebral Osteomyelitis: What has Changed in Last 10 Years?

Vertebral Osteomiyelit: Son 10 Yılda Neler Değişti?

Umran Sumeyse Elbahr **Yusuf Emre Ozdemir** **Ridvan Karaali**

Ilker Inanc Balkan **Nese Saltoglu** **Fehmi Tabak** **Bilgul Mete**

Istanbul University- Cerrahpasa, Cerrahpasa School of Medicine, Infectious Diseases and Clinical Microbiology, Istanbul, Turkey

ABSTRACT

Objective: *This study was conducted to describe the demographic, clinical, and microbiological characteristics of vertebral osteomyelitis in the last decade, mainly by comparing literature and the previous case series performed in our center.*

Material and Methods: *This is a retrospective, observational, descriptive study performed between 2009-2019 at Istanbul University-Cerrahpasa, Cerrahpasa School of Medicine. All patients were divided into three main groups: pyogenic, tuberculous and brucellar.*

Results: *A total of 100 cases were included in this study. Of these 100 patients, 59 had pyogenic, 15 had brucellar and 26 had tuberculous spondylodiscitis. The disease developed postoperatively in 22 (37.4%) of the 59 pyogenic vertebral osteomyelitis cases. The common isolated microorganism was Staphylococcus aureus (n = 11), followed by coagulase negative staphylococci (n = 6). Brucellar vertebral osteomyelitis rate was lower than previous case series (15 vs. 24). The median time to improvement in the laboratory findings after the administration of the appropriate treatment was 14 days. PET-CT was diagnostic in 81.8% of pyogenic vertebral osteomyelitis patients, similar to MRI. However, PET-CT diagnosis rate was significantly low in tuberculous spondylodiscitis (3 out of 9, p = 0.040).*

Conclusion: *S. aureus remained the most common etiologic agent. Coagulase negative staphylococci infection rate, mainly related to spinal surgery, and postoperative spondylodiscitis rate is higher than before. Brucellar vertebral osteomyelitis rate is lower, which is mostly related to effective animal vaccination and pasteurization. Although, MRI is the gold standard, PET-CT is a promising technique in diagnosis for pyogenic vertebral osteomyelitis.*

ÖZET

Amaç: *Bu çalışmada, vertebral osteomyelit vakalarının son 10 yıldaki demografik, klinik ve mikrobiyolojik özelliklerindeki değişimlerin saptanması, bu bulguların mevcut literatür ve hastanemizde yapılan bir önceki vaka serisi ile karşılaştırılması amaçlanmıştır.*

Gereç ve Yöntem: *2009-2019 yılları arasında İstanbul Üniversitesi-Cerrahpaşa Cerrahpaşa Tıp Fakültesi'nde vertebral osteomyelit tanısı ile takip edilen hastaların verileri retrospektif olarak tarandı. Tüm hastalar piyojenik, tüberküloz ve brusellar vertebral osteomyelit olmak üzere üç ana gruba ayrıldı.*

Bulgular: *Çalışmaya toplam 100 vaka dahil edildi. Bu 100 hastanın 59'unda piyojenik, 15'inde brusella ve 26'sında tüberküloz vertebral osteomyeliti saptandı. Piyojenik vertebral osteomyelit vakalarının 22'si (%37.4) postoperatif olarak gelişti. En sık izole edilen mikroorganizma Staphylococcus aureus (n = 11), ardından koagülaz negatif stafilokoklar (n = 6) idi. Brusella vertebral osteomyeliti oranı önceki vaka serilerinden daha düşüktü (15'e karşı 24). Uygun antimikrobiyal tedavinin ardından laboratuvar bulgularında düzelmeye kadar geçen medyan süre 14 gündü. PET-CT, MR'a benzer şekilde piyojenik vertebral osteomyelit hastalarının %81.8'inde tanı koydurucuydu. Ancak tüberküloz vertebral osteomyeliti hastalarında PET-CT tanı oranı anlamlı olarak düşük saptandı (9'da 3, p=0,040).*

Sonuç: *S. aureus en sık izole edilen mikroorganizma olmaya devam etti. Koagülaz negatif stafilokok enfeksiyon oranı artmış olup, temelde postoperatif enfeksiyon ile ilişkilendirilmiştir. Brusella vertebral osteomyeliti oranı daha düşük olarak saptanmıştır. Bu durumun etkili hayvan aşılama programları ve pastörizasyon ile ilişkili olduğu düşünülmüştür. MR tanıda altın standart olmasına rağmen, PET-CT özellikle piyojenik vertebral osteomyelit tanısında umut vericidir.*

Keywords:
Spondylodiscitis
Vertebral osteomyelitis
Pyogenic
Brucellar
Tuberculous

Anahtar Kelimeler:
Spondilodiskit
Vertebral Osteomyelit
Piyojenik
Bruselloz
Tüberküloz

INTRODUCTION

Vertebral osteomyelitis (VO) is an infection of vertebrae and intervertebral disc with an etiology that might be pyogenic, granulomatous (i.e., tuberculous, brucellar, fungal), or parasitic. Such a condition occurs most commonly via a hematogenous route, followed by spreading from adjacent tissues or direct inoculation (1).

Risk factors related to VO include diabetes mellitus (DM), immunosuppression, chronic heart disease, cirrhosis, intravenous drug use, HIV infection, previous spinal surgery, the presence of foreign bodies, chronic renal failure, the presence of an intravascular catheter, or previous bacteremia (2). The VO incidence is rising because of higher life expectancy, higher prevalence

Correspondence: Umran Sumeyse Elbahr. Postal address: Department of Infectious Diseases, Bahrain Oncology Center, King Hamad University Hospital. Muharraq / Bahrain. E-mail: drumran_08@hotmail.com.
Cite as: Elbahr SU, Ozdemir YE, Karaali R, Balkan II, Saltoglu N, Tabak F, Mete B. Vertebral Osteomyelitis: What has Changed in Last 10 Years? Phnx Med J. 2023;5(2):87-93.
Received: 20.01.2023 **Accepted:** 13.02.2023

of chronic diseases, increased spinal surgery, and other invasive procedures that result in bacteremia (3).

Clinical findings are mostly insidious. The most common symptom is pain which is consistent with the level of the involved vertebra. Pyogenic vertebral osteomyelitis (PVO) is usually monomicrobial, and the most common causative agent is Staphylococcus aureus. Additionally, Gram-negative enteric bacilli, coagulase-negative staphylococci (CoNS), Pseudomonas aeruginosa, streptococci, and other rare microorganisms might be included in VO etiology (4,5).

Imaging findings are fundamental for diagnosis, and magnetic resonance imaging (MRI) is considered the most accurate technique due to its high sensitivity and specificity. Computed tomography (CT) is especially useful for detecting bony sequestra and soft tissue abscesses (6). Recently, 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) was indicated promising to diagnose spondylodiscitis when MRI is unavailable or unfeasible (7,8).

This study was conducted to describe the characteristics of the disease in the last decade, mainly by comparing literature and the previous 100-case study performed in our center (9). Specifically, we focused on the following outcomes: comorbidities, etiology, the role of diagnostic modalities, and follow-up parameters.

MATERIALS AND METHODS

In this retrospective observational study, the files of 100 spondylodiscitis cases followed up between 2009–2019 at the Istanbul University Cerrahpaşa, Cerrahpasa Medical Faculty, Department of Infectious Diseases, were evaluated. The study was approved by the Istanbul University Cerrahpasa Medical Faculty Ethics Committee with protocol number 83045809–604.01.02. We collected the data of the patients who were followed with spondylodiscitis diagnosis. The patients with insufficient records were excluded. The cases were divided into three groups: pyogenic, tuberculous, and brucellar spondylodiscitis.

We accepted the VO diagnosis as definite, either when a microorganism was isolated from affected vertebral area, a polymerase chain reaction (PCR) for the Mycobacterium tuberculosis complex was positive, or a typical histopathological pattern of tuberculosis (TB) was observed in aspirated materials with a CT-guided fine-needle aspiration biopsy (FNAB). A homemade nested PCR using primers targeting the MPB 64 proteins of M. tuberculosis was performed as described by Therese et al (10). Diagnosis of brucellar vertebral osteomyelitis (BVO) was established when high serological titers of brucella antibodies (1/160 for Wright's seroagglutination) were reported. Diagnosis was considered as probable when we observed histopathological inflammatory patterns that may suggest it in FNAB. The diagnosis was also considered probable when such patterns were combined with clinical, radiological pictures compatible with VO and when a microorganism was isolated from a blood culture or another coexistent infection site. Their responses to antibacterial treatment supported the probable cases.

We considered as a laboratory response any minimum 25% decrease in baseline C-reactive protein (CRP) or erythrocyte sedimentation rate (ESR) values (or both) after antibiotic treatment. Clinical and laboratory data of the patients were collected from the medical records retrospectively. The patients were followed-up as outpatients for one year after therapy completion.

Statistical Analysis

IBM-SPSS-20 package program was used for statistical analysis. Descriptive data was presented as frequency (n) and percentage (%) for categorical variables and median with interquartile range (IQR). We provided data as mean ± standard deviation. Pearson chi-square test and Fisher's exact test were used for comparing categorical data and the Kruskal–Wallis test was used to compare the nonnormally distributed numeric data. A p value of <0.05 was considered statistically significance level.

RESULTS

One hundred patients were included in this study. The cases consisted of 59 PVO cases, 26 tuberculous vertebral osteomyelitis (TVO) cases, and 15 BVO cases. The diagnosis was definite in 29% of PVO patients and 69% of TVO patients. Fifty-two patients were male and 48 female. The age of the patients ranged from 19 to 90 years; median age (IQR) was 58.5 (46.5-66.8) years. The disease developed postoperatively in 22 (37.4%) of the 59 PVO cases. In the study population, 13 patients were followed up with a misdiagnosis before diagnosing VO. The most common misdiagnosis was lumbar disc hernia (n = 5), followed by myeloproliferative diseases (n = 3), metastasis (n = 2), sarcoidosis (n = 1), pneumonia (n = 1), and gonarthrosis exacerbation (n = 1).

The demographics and clinical features of the patients are shown in Table 1. The age distribution, sex, and baseline clinical findings, except for fever and night sweats, were similar between the study groups. While fever was significantly most common in the BVO patients, weight loss was more frequent in the TVO patients ($p = 0.031$ and $p = 0.005$, respectively). Among the predisposing conditions, DM and previous spine surgery prevalence were significantly higher in the PVO group ($p = 0.027$ and $p = 0.005$, respectively). The TB disease history was statistically higher in TVO patients ($p = 0.019$). Thoracic involvement was significantly higher in the TVO patients ($p = 0.031$). Otherwise, the frequencies of cervical, lumbar, and sacral involvements were similar between groups. Abscess formation was detected in at least one site in 47 of the 100 patients. In TVO patients, abscess existence was significantly higher compared to the other groups ($p = 0.002$). While paravertebral, epidural, paraspinal, and intradural abscess frequencies were similar among the groups, psoas abscesses were more common in the TVO patients ($p = 0.046$; Table 1). Drainage was performed in four patients, and surgical intervention was performed in four patients who developed abscesses.

Mean diagnostic delay value (MDD) was 20.4 (± 41.5) weeks. MDD was 172 (± 256) days for PVO, 193 (± 169) days for TVO and 281 (± 580) days for BVO. There was no statistically significant difference between the sub-groups.

The median leukocyte count was 8600/mm3, median serum CRP level was 30 mg/L, median ESR was 62 mm/h, and median hematocrit (Hct) was 35.0% (± 5%) in

Table 1: Demographics and clinical features of the patients

Characteristics	PVO (n = 59)	TVO (n = 26)	BVO (n = 15)	Total (n = 100)	p
Age (years), median (IQR)	59.0 (51.0-67.0)	53.5 (31.5-66.5)	59.0 (41.0-61.0)	58.5 (46.5-66.8)	0.317[a]
Sex, n (%)					
Female	27 (45.8)	16 (61.5)	5 (33.3)	48 (48.0)	0.190[b]
Male	32 (54.2)	10 (38.5)	10 (66.7)	52 (52.0)	
Baseline findings, n (%)					
Pain	54 (91.5)	25 (96.2)	14 (93.3)	93 (93.0)	0.861[c]
Neurological symptoms	18 (30.5)	5 (19.2)	5 (33.3)	28 (28.0)	0.500[b]
Fever	16 (27.1)	8 (30.8)	9 (60.0)	33 (33.0)	0.031[b]
Fatigue	12 (20.3)	5 (19.2)	5 (33.3)	22 (22.0)	0.513[b]
Weight loss	7 (11.9)	11 (42.3)	5 (33.3)	23 (23.0)	0.005[b]
Night sweating	4 (6.8)	6 (23.1)	3 (20.0)	13 (13.0)	0.070[c]
Predisposing conditions, n (%)					
Cancer history	5 (8.5)	1 (3.8)	0 (0.0)	6 (6.0)	0.594[c]
Rheumatic disease	4 (6.8)	2 (7.2)	1 (6.7)	7 (7.0)	>0.999[c]
DM	15 (25.4)	4 (15.4)	0 (0.0)	19 (19.0)	0.027[c]
Osteomyelitis history	0 (0.0)	1 (3.8)	0 (0.0)	1 (1.0)	0.410[c]
TB disease history	0 (0.0)	3 (11.5)	0 (0.0)	3 (3.0)	0.019[c]
VO history	0 (0.0)	0 (0.0)	1 (6.7)	1 (1.0)	0.150[c]
UTI history	2 (3.4)	1 (3.8)	0 (0.0)	3 (3.0)	>0.999[c]
Any type of infection history	10 (16.9)	6 (23.1)	4 (26.7)	20 (20.0)	0.633[b]
Trauma history	4 (6.8)	2 (7.7)	0 (0.0)	6 (6.0)	0.718[c]
Spine surgery history	23 (39.0)	2 (7.7)	2 (13.3)	27 (27.0)	0.005[b]
Involvement site, n (%)					
Cervical	1 (1.7)	0 (0.0)	0 (0.0)	1 (1.0)	>0.999[c]
Thoracic	11 (18.6)	12 (46.2)	4 (26.7)	27 (27.0)	0.031[b]
Lumbar	51 (86.4)	18 (69.2)	13 (86.7)	82 (82.0)	0.167[c]
Sacral	15 (25.4)	4 (15.4)	5 (33.3)	24 (24.0)	0.399[b]
Multilevel	18 (30.5)	8 (30.8)	7 (46.7)	33 (33.0)	0.474[b]
Abscess formation, n (%)					
Any site	21 (35.6)	20 (76.9)	6 (40.0)	47 (47.0)	0.002[b]
Psoas	4 (6.8)	7 (26.9)	2 (13.3)	13 (13.0)	0.046[c]
Paravertebral	13 (22.0)	12 (46.2)	5 (33.3)	30 (30.0)	0.078[b]
Epidural	6 (10.2)	4 (15.4)	2 (13.3)	12 (12.0)	0.684[b]
Paraspinal	2 (3.4)	1 (3.8)	0 (0.0)	3 (3.0)	>0.999[c]
Intradural	1 (1.7)	0 (0.0)	0 (0.0)	1 (1.0)	0.474[b]

PVO: Pyogenic vertebral osteomyelitis, TVO: Tuberculosis vertebral osteomyelitis, BVO: Brucellar vertebral osteomyelitis, IQR: Interquartile range, DM: Diabetes mellitus, TB: Tuberculosis, VO: Vertebral osteomyelitis, UTI: Urinary tract infection.
a Kruskal-Wallis test was used.
b Pearson chi-square test was used.
c Fisher's exact test was used.
d Osteomyelitis involving bones other than vertebra.
Bold values are statistically significant

our study population. However, there was no statistically significant difference in these parameters among the three study groups (Table 2).

The imaging results of the patients are shown in Table 2. Whereas the MRI results allowed us to observe similar features and achieve high diagnostic success in all study groups, the CT results was diagnostic only one-third of the study group. The diagnostic success obtained with both imaging methods was statistically similar in all groups. However, while PET-CT allowed for a successful diagnosis in 81.8% of PVO patients, successful diagnostic levels decreased significantly in TVO patients (p = 0.040; Table 3).

CT-guided FNAB was performed on 76 patients (47 PVO, 26 TVO, and 3 BVO). In PVO patients, microbiological evaluation was performed in 26 non-postoperative and 15 postoperative patients. The microbiological analysis could not be done in six non-postoperative cases due to

Table 2: Laboratory findings of the patients

Characteristics	PVO	TVO	BVO	Total	p
WBC (/mm3), median (IQR)	8790 (6950-11125)	7820 (6400-9800)	7150 (5675-9450)	8600 (6500-10300)	0.180[a]
CRP (mg/L), median (IQR)	25.0 (13.0-90.0)	30.0 (17.0-98.0)	80.5 (24.8-110.3)	30.0 (15.0-90.5)	0.297[a]
ESR (mm/h), median (IQR)	57.0 (42.5-95.0)	71.0 (38.5-89.5)	72.0 (26.5-99.5)	62.0 (40.0-93.0)	0.946[a]
Hct (%), median (IQR)	35.0 (30.0-39.0)	34.4 (31.5-37.5)	35.5 (31.8-38.8)	35.0 (30.8-39.0)	0.792[a]

WBC: White blood cell count, CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, Hct: Hematocrit, PVO: Pyogenic vertebral osteomyelitis, TVO: Tuberculosis vertebral osteomyelitis, BVO: Brucellar vertebral osteomyelitis.
a Kruskal-Wallis test was used.

Table 3: Imaging features of the patients

Imaging wtechnique	PVO n (%)	TVO n (%)	BVO n (%)	Total n (%)	p
MRI					
Negative	0 (0.0)	0 (0.0)	1 (7.1)	1 (1.1)	0.161[a]
Positive	52 (100.0)	21 (100.0)	13 (92.9)	86 (98.9)	
CT					
Negative	6 (66.7)	5 (62.5)	1 (100.0)	12 (66.7)	>0.999[a]
Positive	3 (33.3)	3 (37.5)	0 (0.0)	6 (33.3)	
PET-CT					
Negative	2 (18.2)	6 (66.7)	1 (100.0)	9 (42.9)	0.040[a]
Positive	9 (81.8)	3 (33.3)	0 (0.0)	12 (57.1)	

MRI: Magnetic resonance imaging, CT: Computerized tomography, PET-CT: Positron emission tomography/computed tomography, PVO: Pyogenic vertebral osteomyelitis, TVO: Tuberculosis vertebral osteomyelitis, BVO: Brucellar vertebral osteomyelitis.
a Fisher's exact test was used.
Bold values are statistically significant

Table 4: Fine needle aspiration biopsy results of TVO patients

Characteristics	TVO (n = 26)
Microbiological, n (%)	
AFB staining positivity	1 (3.8)
TB culture positivity	8 (30.8)
PCR positivity	13 (50.0)
Histopathological, n (%)	
Granulomatous reaction	9 (31.7)
Nonspecific inflammatory findings	11 (42.3)
Diagnosis, n (%)	
Solely Microbiological	11 (42.3)
Solely Histopathological	2 (7)
Microbiologically and histopathological	5 (19.2)
Upon empirical treatment response	8 (30.7)

TVO: Tuberculosis vertebral osteomyelitis, AFB: Acid-fast bacillus, TB: Tuberculosis, PCR: Polymerase chain reaction.

insufficient samples. The positivity of biopsy specimens was 12 out of 26 and five out of 15 patients for non-postoperative and postoperative patients, respectively. In TVO patients, one of them (3.8%) was positive for acid-resistant bacilli (ARB) staining, eight (30.8%) were TB culture positive, and 13 (50.0%) were TB PCR positive. Histopathological examinations were performed on 20 TVO patients. Granulomatous changes were detected in nine patients, while non-specific inflammatory changes were observed in 11 ones. The diagnosis of the 26 TVO patients was made by microbiological or histopathological findings (or both) and upon empirical treatment response (Table 4).

Within the pyogenic group, the microbiological diagnosis was established in 20 out of 41 patients (48.7%). Eight (40%) of these 20 patients were methicillin-sensitive Staphylococcus aureus (MSSA), and the remaining were as follows: six CoNS (four of them were methicillin-resistant and two of them were methicillin-sensitive), three were methicillin-resistant S. aureus (MRSA), one was Escherichia coli, one was Pseudomonas aeruginosa, and one was viridans group streptococci. The remaining patients did not yield any bacteria in the blood culture or biopsy culture (Table 5).

The median time to improvement in the laboratory findings of the study population after the administration of the appropriate treatment was 14 days. Follow-up inflammatory markers were not obtained before four weeks of therapy in six patients. The median treatment response times in the laboratory parameters were statistically similar among the three groups. While the median time for pain relief for the entire study group was 21 days, it was statistically significantly reduced to 14 days in the BVO patients (p = 0.034; Table 6). After treatment completion, relapse was observed in one BVO and one PVO patient. There were no deaths among the patients.

Table 5: Microorganisms isolated from the patients with pyogenic vertebral osteomyelitis

Culture results	Non-postoperative PVO (n = 37)	Postoperative PVO (n = 22)	Total (n = 59)
MSSA	7	1	8
MRSA	3	0	3
MSCoNS	2	0	2
MRCoNS	1	3	4
Viridans group streptococci	1	0	1
Pseudomonas aeruginosa	0	1	1
Escherichia coli	1	0	1

PVO: Pyogenic vertebral osteomyelitis, MSSA: Methicillin-sensitive Staphylococcus aureus, MRSA: Methicillin-resistant Staphylococcus aureus, MSCoNS: Methicillin-sensitive coagulase-negative staphylococci, MRCoNS: Methicillin-resistant coagulase-negative staphylococci.

Table 6: Response time after treatment

Treatment response	PVO (n = 59)	TVO (n = 26)	BVO (n = 15)	Total (n = 100)	p
Improvement in laboratory findings (days), median (IQR)	10.0 (3.0-21.0)	14.0 (7.0-30.0)	14.0 (7.0-30.0)	14.0 (5.0-30.0)	0.097
Pain relief (days), median (IQR)	21.0 (14.0-30.0)	30.0 (26.3-82.5)	14.0 (14.0-30.0)	21.0 (14.0-30.0)	0.034

Bold values are statistically significant

DISCUSSION

Although VO is not a frequent disease, its annual hospitalization incidence has been increasing up to 5.4 per 100,000 (11) because of the population aging, increasing the number of immunocompromised patients, bacteremia due to intravascular devices, and spinal instrumentation (9). The male ratio was reported in the related literature from 52 percent of the patients up to twice as often as women (1,11) and the male ratio (52%) was similar in our study. Most VO cases occur in patients > 50 years old. Likewise, the mean age in our series at the time of diagnosis was 55 ± 14 years (mean ± standard deviation).

The primary clinical manifestation of VO is insidious spinal pain in the affected area. Spinal pain was reported in 67–100% of the patients in some studies (5,12,13). Fever is a much less frequent symptom. Chelsom et al. showed that only 37.5% of the patients in their study had a fever, regardless of the etiology (14). The fever frequency was reported in a range of 35–60% in another study (3). Similarly, 93% and 33% of our patients suffered from spinal pain and fever, respectively. A wide range of neurological symptoms might also be observed, from mild limited motion to paralysis (11). As in the previous studies, neurologic involvement was detected in 28% of the patients in our study.

The range of MDD was reported as two to 36 weeks (9,15,16). In our study, the MDD was 20.4 weeks. For patients with TB VO, MDD was reported up to 22 months in one study (17). Contrarily, there were no significant differences in our patient groups. Despite improving the imaging modality and increasing awareness and incidence, the MDD results were similar to the previous studies.

Although most of the studies showed significantly high inflammatory markers in PVO, (18–20) there were no significant differences among the three groups in our study. In addition, 64% and 17% of the patients had normal WBC and ESR levels, respectively. These findings are consistent with previous studies (20,21). Although CRP and ESR are usually elevated in VO, (14) normal inflammatory marker levels cannot rule out the diagnosis (22).

Spinal MRI is recommended as the first choice of radiologic modality for diagnosis. When MRI is not available, a combination of spine gallium and Tc99 bone scan, computed tomography, or PET scan can be performed (7). Although CT is useful for detecting bony sequestra and adjacent soft tissue abscesses, it is inferior to MRI for VO diagnosis (6). In this study, MRI and CT were diagnostic in 94.5% and 33% of the patients, respectively. Previously, the 18F-FDG PET/CT accuracy rates were reported as 94% (23). Here, the 18F-FDG PET/CT was performed in 21 patients; only 12 (57%) of them were diagnosed with VO, and five (24%) were misdiagnosed with metastasis. But since the number of patients having performed CT or PET/CT is low, the results should be evaluated cautiously.

CT-guided FNAB was performed in 76% of patients. This rate is consistent with that reported in the literature (48–100%) (5,9).

The lumbar vertebral bodies are most often involved, followed by thoracic and, less commonly, cervical vertebrae (11). The most common infection site in this study was the lumbar spine (49%), followed by the lumbosacral (22%) and thoracic (16%) sites, which is consistent with a previous report from our institute (9).

In our series, PVO was the most frequent disease (n = 59), and 37% of cases had a spinal surgery history. The number of postoperative case was 10 out of 44 PVO cases in the study previously conducted in our center (9). Several studies reported that 19–47% of patients had undergone spinal surgery before PVO diagnosis (24). Lumbar involvement was the most frequently infected area (56%), similar to other previously conducted studies (3). Our study confirmed that DM is a predisposing factor for pyogenic spondylodiskitis, as observed in many other studies (14,17,19).

The PET-CT diagnostic value was significantly higher (81.8%) in PVO patients. The study comparing 18F-FDG PET and MRI for VO diagnosis showed similar accuracy,

75% vs. 81%, respectively. Hence, 18F-FDG PET could be used as an alternative diagnostic modality for PVO if diagnostic doubt remains after MRI or when MRI is unavailable (25).

Microbiological evaluation of biopsies was done in 41 PVO cases. Of these, 41.4% had significant growth. Similarly, Colmenero et al. reported 49% bone biopsy culture positivity in PVO patients (19). Although S. aureus was still the most common organism (15%), the proportion of CoNS (8%) was higher than that previously reported in our center (n=0) (9). Coagulase-negative staphylococci, frequently associated with postoperative infection or intracardiac device-related sepsis, (26) were found in 5–16% of the PVO cases. Such an increasing rate of CoNS in our center might be explained by the growing rate of postoperative vertebral osteomyelitis in all instances (n = 22 vs. n = 10).

An adequate response manifests as both resolution of fever and back pain with a weekly 50% decrease in CRP levels (27). Furthermore, in a retrospective analysis of 61 patients treated with shorter antibiotic courses, the only independent predictor of the early switch to oral antibiotics was a lower CRP at two weeks than at baseline (28). Similarly, in our study, the median time to improve laboratory findings after administering the appropriate treatment was 14 days.

Brucellar VO is common in Turkey and other Mediterranean countries (22). The spondylodiscitis incidence due to brucellosis was reported as 2–58% (29). In this study, the rate of BVO (15%) was lower than in the previous 10 years (24%) in the same center (9). Such a decrease is likely related to the decreasing brucellosis cases in Turkey (30).

Fever was significantly more common in BVO patients than in other patients, and this finding is similar to the series reported by Horasan et al. (31).

In endemic countries, TB remains a significant cause of spinal infection. The spine is one of the most commonly affected sites of extrapulmonary TB (32). As in previous studies, thoracic vertebral involvement was significantly higher in the TVO group in our study (33). Previous studies reported a relatively higher frequency of paraspinal, epidural (19), and psoas abscesses (20) among patients with TVO. We observed in our data that TVO patients had significantly higher psoas abscesses, while paravertebral, epidural, paraspinal, and intradural abscesses frequencies were similar among the groups.

Although PET-CT looks promising for spondylodiscitis diagnosis,(8,34) its diagnostic success was significantly low (33.3%) for TVO patients in our study. Differential diagnosis could not be made between TVO and metastasis (n = 2), myeloproliferative disease (n = 1), and sarcoidosis (n = 1). However, the number of patients was small (n = 9).

This study is limited by its observational and retrospective design; thus, it cannot account for potential unmeasured confounding effects. Additionally, this is a single-center study; hence, both local microbial patterns and clinical practice may vary in other regions. Finally, our center is a tertiary teaching hospital with spinal surgery units represent a referral bias.

CONCLUSION

In conclusion, VO is a typical disease in elderly patients and the male gender. In endemic areas, both TVO and BVO should be kept in mind in the differential diagnosis. Symptoms might be insidious, and diagnosis requires a high index of suspicion. The lumbar vertebral level is mainly involved in each patient group, whereas thoracic involvement is more prominent in TVO group. Although MRI is the gold standard for diagnosing spinal infections, PET-CT is a promising technique, especially for PVO. Although PET-CT diagnostic rate was lower in TVO patients in our study, there is a need for large-scale studies. S. aureus remains the most common organism causing VO, and methicillin-resistant CoNS is mainly related to postoperative infection. Postoperative spondylodiscitis rate is higher, and BVO rate is lower than before. Lower BVO rate is mostly related to effective animal vaccination and pasteurization.

Conflict of Interest: No conflict of interest was declared by the authors.
Ethics: The study was approved by the Istanbul University Cerrahpasa Medical Faculty Ethics Committee with protocol number 83045809–604.01.02.
Funding: There is no financial support of any person or institution in this research.
Approval of final manuscript: All authors.

REFERENCES

1. Nickerson EK, Sinha R. Vertebral osteomyelitis in adults: An update. Br Med Bull. 2016;117(1):121–38.
2. Akiyama T, Chikuda H, Yasunaga H, Horiguchi H, Fushimi K, Saita K. Incidence and risk factors for mortality of vertebral osteomyelitis: a retrospective analysis using the Japanese diagnosis procedure combination database. BMJ Open. 2013;3(3):e002412.
3. Mustapić M, Višković K, Borić I, Marjan D, Zadravec D, Begovac J. Vertebral osteomyelitis in adult patients--characteristics and outcome. Acta clinica Croatia. 2016;55(1):9–15.
4. Corrah TW, Enoch DA, Aliyu SH, Lever AM. Bacteraemia and subsequent vertebral osteomyelitis: a retrospective review of 125 patients. QJM. 2011;104(3):201–7.
5. Mylona E, Samarkos M, Kakalou E, Fanourgiakis P, Skoutelis A. Pyogenic vertebral osteomyelitis: a systematic review of clinical characteristics. Semin Arthritis Rheum. 2009;39(1):10–7.
6. An HS, Seldomridge JA. Spinal infections: diagnostic tests and imaging studies. Clin Orthop Relat Res. 2006;444:27–33.
7. Berbari EF, Kanj SS, Kowalski TJ, Darouiche RO, Widmer AF, Schmitt SK, et al. 2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults. Clinical Infectious Diseases. 2015;61(6):e26-46.
8. Bassetti M, Carnelutti A, Muser D, Righi E, Petrosillo N, Gregorio F Di, et al. 18F-Fluorodeoxyglucose positron emission tomography and infectious diseases: current applications and future perspectives. Curr Opin Infect Dis. 2017;30(2):192–200.
9. Mete B, Kurt C, Yilmaz MH, Ertan G, Ozaras R, Mert A, et al. Vertebral osteomyelitis: eight years' experience of 100 cases. Rheumatol Int.

2012;32(11):3591–7.
10. Therese KL, Jayanthi U, Madhavan HN. Application of nested polymerase chain reaction (nPCR) using MPB 64 gene primers to detect Mycobacterium tuberculosis DNA in clinical specimens from extrapulmonary tuberculosis patients. Indian J Med Res. 2005;122(2):165–70.
11. McDonald M (2020) Vertebral osteomyelitis and discitis in adults. In: UpToDate, Post, TW (Ed), UpToDate, Waltham, MA.
12. Kehrer M, Pedersen C, Jensen TG, Lassen AT. Increasing incidence of pyogenic spondylodiscitis: a 14-year population-based study. J Infect. 2014;68(4):313–20.
13. Loibl M, Stoyanov L, Doenitz C, Brawanski A, Wiggermann P, Krutsch W, et al. Outcome-related co-factors in 105 cases of vertebral osteomyelitis in a tertiary care hospital. Infection. 2014;42(3):503–10.
14. Chelsom J, Solberg CO. Vertebral osteomyelitis at a Norwegian university hospital 1987-97: clinical features, laboratory findings and outcome. Scand J Infect Dis. 1998;30(2):147–51.
15. Gouliouris T, Aliyu SH, Brown NM. Spondylodiscitis: update on diagnosis and management. J Antimicrob Chemother. 2010;65 Suppl 3:iii11-24.
16. Beronius M, Bergman B, Andersson R. Vertebral osteomyelitis in Göteborg, Sweden: a retrospective study of patients during 1990-95. Scand J Infect Dis. 2001;33(7):527–32.
17. Perronne C, Saba J, Behloul Z, Salmon-Céron D, Leport C, Vildé JL, et al. Pyogenic and tuberculous spondylodiskitis (vertebral osteomyelitis) in 80 adult patients. Clinical Infectious Diseases. 1994;19(4):746–50.
18. Weisz RD, Errico TJ. Spinal infections. Diagnosis and treatment. Bull Hosp Jt Dis. 2000;59(1):40–6.
19. Colmenero JD, Jiménez-Mejías ME, Sánchez-Lora FJ, Reguera JM, Palomino-Nicás J, Martos F, et al. Pyogenic, tuberculous, and brucellar vertebral osteomyelitis: a descriptive and comparative study of 219 cases. Annals of rheumatic diseases. 1997;56(12):709–15.
20. Gök SE, Kaptanoğlu E, Celikbaş A, Ergönül O, Baykam N, Eroğlu M, et al. Vertebral osteomyelitis: clinical features and diagnosis. Clinical microbiology and infection. 2014;20(10):1055–60.
21. Lemaignen A, Ghout I, Dinh A, Gras G, Fantin B, Zarrouk V, et al. Characteristics of and risk factors for severe neurological deficit in patients with pyogenic vertebral osteomyelitis: A case-control study. Medicine (Baltimore). 2017;96(21):e6387.
22. Saeed K, Esposito S, Ascione T, Bassetti M, Bonnet E, Carnelutti A, et al. Hot topics on vertebral osteomyelitis from the International Society of Antimicrobial Chemotherapy. Int J Antimicrob Agents. 2019;54(2):125–33.
23. Altini C, Lavelli V, Niccoli-Asabella A, Sardaro A, Branca A, Santo G, et al. Comparison of the Diagnostic Value of MRI and Whole Body 18 F-FDG PET/CT in Diagnosis of Spondylodiscitis. J Clin Med. 2020;9(5):1581.
24. Kwon JW, Hyun SJ, Han SH, Kim KJ, Jahng TA. Pyogenic Vertebral Osteomyelitis: Clinical Features, Diagnosis, and Treatment. Korean J Spine. 2017;14(2):27–34.
25. Skanjeti A, Penna D, Douroukas A, Cistaro A, Arena V, Leo G, et al. PET in the clinical work-up of patients with spondylodiscitis: a new tool for the clinician? The quarterly journal of nuclear medicine and molecular imaging. 2012;56(6):569–76.
26. Fantoni M, Trecarichi EM, Rossi B, Mazzotta V, Giacomo G Di, Nasto LA, et al. Epidemiological and clinical features of pyogenic spondylodiscitis. Eur Rev Med Pharmacol Sci. 2012;16 Suppl 2:2–7.
27. Grados F, Lescure FX, Senneville E, Flipo RM, Schmit JL, Fardellone P. Suggestions for managing pyogenic (non-tuberculous) discitis in adults. Joint Bone Spine. 2007;74(2):133–9.
28. Flury BB, Elzi L, Kolbe M, Frei R, Weisser M, Schären S, et al. Is switching to an oral antibiotic regimen safe after 2 weeks of intravenous treatment for primary bacterial vertebral osteomyelitis? BMC Infect Dis. 2014;14:226.
29. Unuvar GK, Kilic AU, Doganay M. Current therapeutic strategy in osteoarticular brucellosis. North Clin Istanb. 2019;6(4):415–20.
30. Republic of Turkey Ministery of Health, Turkish Public Health Institution, Department of Zoonotic and Vector Borne Diseases. Brucellosis Statistical Data. https://hsgm.saglik.gov.tr/tr/zoonotikvektorel-bruselloz/istatistik (Accessed on March 26, 2021).
31. Horasan ES, Colak M, Ersöz G, Uğuz M, Kaya A. Clinical findings of vertebral osteomyelitis: Brucella spp. versus other etiologic agents. Rheumatol Int. 2012;32(11):3449–53.
32. Jain AK, Rajasekaran S. Tuberculosis of the spine. Indian J Orthop. 2012;46(2):127–9.
33. Colmenero JD, Ruiz-Mesa JD, Sanjuan-Jimenez R, Sobrino B, Morata P. Establishing the diagnosis of tuberculous vertebral osteomyelitis. European Spine Journal. 2013;22 Suppl 4(Suppl 4):579–86.
34. Kouijzer IJE, Scheper H, Rooy JWJ de, Bloem JL, Janssen MJR, Hoven L van den, et al. The diagnostic value of 18 F-FDG-PET/CT and MRI in suspected vertebral osteomyelitis - a prospective study. Eur J Nucl Med Mol Imaging. 2018;45(5):798–805.