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COMPARISON OF CLINICAL, LABORATORY, AND RADIOLOGICAL CHARACTERISTICS OF SPONDYLODISCITIS ACCORDING TO ETIOLOGY: A 10-YEAR SINGLE-CENTER RETROSPECTIVE STUDY

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ABSTRACT

Objective: This study aimed to compare the clinical, laboratory, and radiological characteristics of spondylodiscitis caused by pyogenic microorganisms, *Brucella* spp., and *Mycobacterium tuberculosis*.

Materials and Methods: Patients diagnosed with spondylodiscitis at a single-center between January 2014 and December 2024 were retrospectively reviewed. Contrast-enhanced magnetic resonance imaging (MRI) was performed in all cases during the diagnostic evaluation. Patients were categorized into three groups according to etiology: pyogenic spondylodiscitis (PSD), brucellar spondylodiscitis (BSD), and tuberculous spondylodiscitis (TSD). The diagnosis was established based on clinical presentation, laboratory findings, and MRI features and supported by microbiological and/or histopathological confirmation when available.

Results: A total of 122 patients were included: 81 (66.4%) with PSD, 29 (23.8%) with BSD, and 12 (9.8%) with TSD. The mean age was significantly higher in the PSD group (p=0.009). Motor neurological deficits were more frequently observed in patients with TSD (p<0.001). Pre-treatment and follow-up C-reactive protein levels were significantly higher in the PSD group than those in the other groups (p<0.05). Lumbar involvement was the most common site across all groups. Abscess formation was observed most frequently in PSD, and paravertebral abscesses were the predominant type. Patients who underwent surgical treatment achieved high rates of clinical and laboratory remission. Antibiotic therapy was continued for at least six weeks in those who achieved remission.

Conclusion: Clinical presentation, inflammatory response, and neurological involvement in spondylodiscitis vary according to the causative pathogen. Recognition of these etiology-related differences may facilitate earlier diagnosis and guide appropriate treatment strategies, thereby improving infection control and reducing the risk of neurological complications.

Keywords: Spondylodiscitis, pyogenic, Brucella, tuberculosis, spinal infections

INTRODUCTION

Spondylodiscitis is an infection involving the vertebral bodies and the intervertebral disc space and may lead to substantial morbidity when diagnosis and treatment are delayed[1]. The clinical presentation is frequently non-specific and commonly includes back or thoracic pain, fever, and general malaise[2]. Because of these non-specific symptoms, diagnosis may be delayed, particularly in elderly individuals and patients with multiple comorbidities, increasing the risk of neurological complications[3].

Pyogenic microorganisms are the most frequent causative agents of spondylodiscitis; however, specific pathogens such as *Brucella* spp. and *Mycobacterium tuberculosis* also contribute significantly to the disease burden[4-6]. The clinical course and radiological features of the infection may vary depending on the causative organism. Pyogenic spondylodiscitis (PSD) generally presents with an acute clinical course and a marked inflammatory response. In contrast, tuberculous spondylodiscitis (TSD) often develops insidiously and may lead to delayed diagnosis and a higher rate of neurological deficits. Brucellar spondylodiscitis (BSD) is particularly relevant in endemic regions, where serological tests play a key role in the diagnostic process[6-8].

Management of spondylodiscitis requires a multidisciplinary approach involving infectious disease specialists, radiologists, and spine surgeons. Early identification of the causative organism is essential for selecting appropriate antimicrobial therapy, determining surgical indications, and preventing neurological deterioration. Nevertheless, studies directly comparing the clinical, laboratory, and radiological

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characteristics of different etiological forms of spondylodiscitis remain relatively limited. Country-specific data are particularly valuable in regions where infections such as brucellosis remain endemic. Magnetic resonance imaging (MRI) is currently considered the primary imaging modality for the diagnosis of spondylodiscitis and for evaluating the extent of infection and associated complications[3,9].

The present study aimed to compare the clinical, laboratory, and radiological features of pyogenic, brucellar, and TSD in patients treated at a single-center over a 10-year period and to evaluate how etiological differences influence the clinical management of this disease.

MATERIALS AND METHODS

Study Design and Patient Selection

This retrospective observational study evaluated patients who were diagnosed with spondylodiscitis and followed at a single-center between January 2014 and December 2024. Ethical approval was obtained from the Scientific Research Ethics Committee of University of Health Sciences Türkiye, Erzurum Faculty of Medicine (approval no: 2026/01-29, date: 14.01.2026).

Contrast-enhanced MRI was performed in all patients during the diagnostic evaluation, and radiological assessment was based on these images.

Patients aged 18 years or older with a diagnosis of spondylodiscitis based on clinical findings, laboratory parameters, and radiological evidence were eligible for inclusion. A minimum follow-up period of six months was required. Patients with incomplete clinical data, missing radiological imaging, or insufficient follow-up were excluded from the study.

Diagnostic Criteria and Etiological Classification

The diagnosis of spondylodiscitis was established through a combined evaluation of clinical findings (vertebral pain, fever, weight loss), laboratory parameters [elevated C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR)], and contrast-enhanced MRI findings. Etiological diagnosis was supported by microbiological and/or histopathological confirmation when available.

Patients were classified into three groups according to the etiological agent:

- **PSD:** Diagnosis was based on compatible clinical and radiological findings together with the isolation of pyogenic bacteria from blood cultures, tissue cultures, or surgical specimens, or on a favorable clinical and laboratory response to antibiotic therapy.
- **BSD:** Patients with a serum tube agglutination test titer ⩾1:160 and/or positive Coombs anti-*Brucella* test, in conjunction with clinical and radiological findings consistent with spondylodiscitis, were classified as BSD. Culture positivity, when present, was considered confirmatory.
- **TSD:** Diagnosis was established based on positive *Mycobacterium tuberculosis* culture results, histopathological evidence of granulomatous inflammation, or a favorable clinical and radiological response to antituberculous therapy.

Clinical and Demographic Data

Patient data including age, sex, comorbidities (hypertension, diabetes mellitus, cardiovascular diseases), history of previous spinal surgery, and presenting symptoms (vertebral pain, fever, weight loss) were recorded. Neurological status was evaluated based on clinical examination, with particular attention to the presence of motor deficits.

Laboratory Evaluation

Laboratory parameters measured before treatment and during follow-up were retrospectively reviewed for all patients. Evaluated parameters included CRP, ESR, and white blood cell (WBC) count. CRP values were comparatively analyzed at baseline, at the first month, and at the third month of treatment.

Radiological Evaluation

All patients underwent contrast-enhanced MRI at the time of diagnosis. MRI findings were evaluated for vertebral body and intervertebral disc involvement consistent with spondylodiscitis, bone marrow edema, signal changes within the disc space, and the presence of associated epidural, paravertebral, or psoas abscesses. Computed tomography was used when necessary for a more detailed assessment of bony destruction (Figure 1). The level of involvement was classified as cervical, thoracic, or lumbar.

Microbiological Assessment

Results of blood cultures and cultures obtained from biopsy or intraoperative tissue specimens were recorded. Isolated microorganisms were classified according to etiology. Serological test results were considered for brucellar cases, while culture and histopathological findings were evaluated for tuberculous cases.

Surgical Treatment and Antibiotic Management

Surgical intervention was considered in patients presenting with progressive neurological deficit, spinal instability, failure of conservative treatment, advanced vertebral destruction, or epidural or paravertebral abscess formation.

The choice of surgical approach was determined individually according to the patient's clinical status, the level of involvement, and the suspected etiological agent.

Spinal instrumentation was performed when mechanical instability was present or when stabilization was required after decompression. Previous studies have demonstrated that active infection does not represent an absolute contraindication to spinal stabilization.

In patients requiring surgical treatment, the timing of surgery was determined according to clinical and radiological findings. Patients presenting with neurological deficits, epidural abscess,

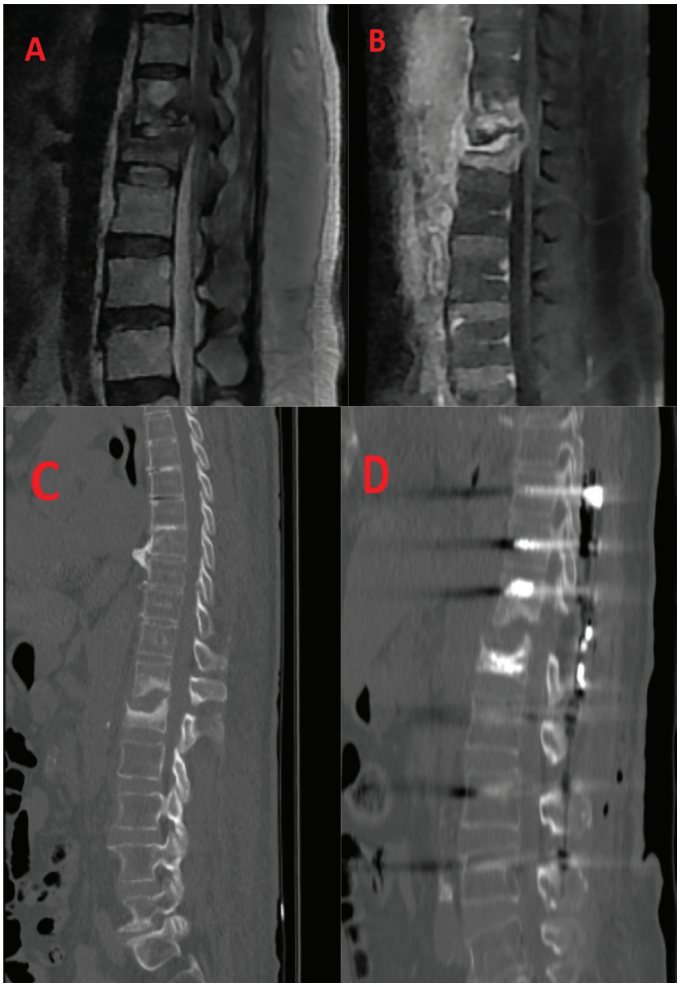

Figure 1. (**A**) Preoperative MRI demonstrating destructive spondylodiscitis at the T12-L1 level with epidural canal invasion in a patient presenting with neurological deficit. (**B**) Preoperative contrast-enhanced MRI of the same patient showing enhancement consistent with infectious involvement. (**C**) Preoperative CT image demonstrating bony destruction at the T12-L1 level. (**D**) Postoperative imaging of the same patient after surgical treatment showing debridement, posterior stabilization, and vertebroplasty performed for infection control and spinal stability. MRI: Magnetic resonance imaging, CT: Computed tomography

severe vertebral destruction, or spinal instability underwent surgical intervention at the time of diagnosis. Patients who developed clinical or radiological progression during conservative treatment underwent surgery during the follow-up period.

Whenever possible, tissue samples were obtained before the initiation of antibiotic therapy. Percutaneous or open biopsy was performed for microbiological culture and antibiogram analysis. Antibiotic treatment was adjusted according to microbiological results when available. In patients with severe clinical signs of infection, empirical antibiotic therapy was started after biopsy and later modified according to culture findings.

Treatment adequacy was evaluated based on clinical improvement, reduction of inflammatory markers, and stabilization of radiological findings.

All patients initially received etiology-specific intravenous antibiotic therapy, followed by oral treatment depending on clinical response and laboratory parameters. In patients who achieved clinical and laboratory remission, antibiotic therapy was continued for at least six weeks.

Statistical Analysis

Statistical analyses were performed using SPSS software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as numbers and percentages. Group comparisons were conducted using analysis of variance or the Kruskal-Wallis test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

A total of 122 patients were included in the study. Of these, 81 patients (66.4%) were diagnosed with PSD, 29 patients (23.8%) with BSD, and 12 patients (9.8%) with TSD. The mean age was significantly higher in the PSD group compared with the other groups (p=0.009). There was no statistically significant difference in sex distribution among the groups (p=0.240).

Evaluation of comorbidities revealed that hypertension and cardiovascular disease were significantly more frequent in the PSD group (p=0.028 and p=0.047, respectively). A history of previous spinal surgery was also significantly more common in the PSD group compared with the other groups (p=0.001).

The most common presenting symptom was vertebral pain, observed in 95.9% of all patients. Weight loss and motor neurological deficits were significantly more frequent in patients with TSD (p=0.006 and p<0.001, respectively) (Table 1).

Laboratory Findings

Pre-treatment CRP and ESR levels were significantly higher in the PSD group compared with the other groups. CRP levels in the PSD group remained higher at both the first and third months of treatment. WBC counts were generally similar among the groups (Table 2).

Radiological Findings

Radiological evaluation revealed that lumbar vertebral involvement was the most common localization across all groups (49.2%). Abscess formation was detected in 55.7% of the patients. Abscesses were more frequently observed in the PSD group, with paravertebral abscess being the most common abscess type (Table 3).

Microbiological Findings

In the PSD group, *Staphylococcus aureus* was the most frequently isolated pathogen, followed by Gram-negative bacteria. In the majority of patients diagnosed with BSD, the diagnosis was established based on serological tests, while culture

positivity was detected in a limited number of cases. In the TSD group, a substantial proportion of patients demonstrated culture positivity for *Mycobacterium tuberculosis*. Overall, microbiological findings highlighted differences in diagnostic approaches according to the etiological agent (Table 4).

Surgical Treatment and Clinical Outcomes

In patients who underwent surgical treatment, effective pain control was achieved in the early postoperative period, allowing early mobilization. No cases of infection control failure or implant-related complications were observed in patients who received spinal instrumentation.

Clinical remission was defined as marked improvement or resolution of vertebral pain, normalization of body temperature, and normalization of inflammatory markers (CRP and ESR). In patients who met these criteria, antibiotic therapy was completed for a minimum duration of six weeks. Clinical and laboratory remission rates were high among surgically treated patients (Table 5).

Table 1. Demographic and clinical characteristics of patients according to etiology

Characteristic	PSD (n=81)	BSD (n=29)	TSD (n=12)	Total (n=122)	p-value
Age, mean ± SD (years)	60.8±12.9	52.2±13.7	49.3±19.4	57.6±14.6	0.009
Male sex, n (%)	40 (49.4)	19 (65.5)	5 (41.7)	64 (52.5)	0.240
Hypertension, n (%)	25 (30.9)	2 (6.9)	2 (16.7)	29 (23.8)	0.028
Diabetes mellitus, n (%)	21 (25.9)	3 (10.3)	4 (33.3)	28 (23.0)	0.154
Cardiovascular disease, n (%)	11 (13.6)	0	0	11 (9.0)	0.047
History of spinal surgery, n (%)	27 (33.3)	1 (3.4)	0	28 (23.0)	0.001
Vertebral pain, n (%)	79 (97.5)	27 (93.1)	11 (91.7)	117 (95.9)	0.433
Fever, n (%)	31 (38.3)	15 (51.7)	6 (50.0)	52 (42.6)	0.391
Weight loss, n (%)	10 (12.3)	7 (24.1)	6 (50.0)	23 (18.9)	0.006
Motor neurological deficit, n (%)	3 (3.7)	0	4 (33.3)	7 (5.7)	<0.001

PSD: Pyogenic spondylodiscitis, BSD: Brucellar spondylodiscitis, TSD: Tuberculous spondylodiscitis, SD: Standard deviation

Table 2. Laboratory findings according to etiology

Laboratory parameter	PSD	BSD	TSD	Total	p-value
Pre-treatment CRP (mg/L), mean ± SD	88.0±79.9	42.2±32.8	68.4±73.8	75.2±73.1	0.036
CRP at 1 month (mg/L), mean ± SD	40.4±45.2	15.1±18.7	38.7±42.5	34.3±41.4	0.007
CRP at 3 months (mg/L), mean ± SD	21.6±31.8	9.1±12.9	19.6±23.9	18.5±28.0	0.045
Pre-treatment ESR (mm/h), mean ± SD	67.3±33.5	48.9±30.3	61.6±32.4	62.3±33.3	0.048
Pre-treatment WBC ($\times 10^9$/L), mean ± SD	Similar among groups	Similar among groups	Similar among groups	-	>0.05

PSD: Pyogenic spondylodiscitis, BSD: Brucellar spondylodiscitis, TSD: Tuberculous spondylodiscitis, CRP: C-reactive protein, WBC: White blood cell, SD: Standard deviation

Table 3. Radiological findings according to etiology

Radiological finding	PSD n (%)	BSD n (%)	TSD n (%)	Total n (%)
Lumbar involvement	44 (54.3)	13 (44.8)	3 (25.0)	60 (49.2)
Thoracic involvement	15 (18.5)	9 (31.0)	5 (41.7)	29 (23.8)
Abscess presence	54 (66.7)	8 (27.6)	6 (50.0)	72 (55.7)
Paravertebral abscess	39 (48.1)	6 (20.7)	2 (16.7)	47 (39.3)

PSD: Pyogenic spondylodiscitis, BSD: Brucellar spondylodiscitis, TSD: Tuberculous spondylodiscitis

Table 4. Microbiological findings according to etiology

Microorganism	PSD n (%)	BSD n (%)	TSD n (%)	Total n (%)
Staphylococcus aureus	24 (29.7)	-	-	24 (19.7)
Escherichia coli	6 (7.4)	-	-	6 (4.9)
Mycobacterium tuberculosis	-	-	8 (66.7)	8 (6.6)
Brucella spp.	-	2 (6.9)	-	2 (1.6)

PSD: Pyogenic spondylodiscitis, BSD: Brucellar spondylodiscitis, TSD: Tuberculous spondylodiscitis

Table 5. Surgical treatment and clinical outcomes

Parameter	Surgically treated (n=48)	Conservatively treated (n=74)	p-value
Motor neurological deficit, n (%)	6 (12.5)	1 (1.4)	<0.001
Presence of abscess, n (%)	39 (81.3)	33 (44.6)	<0.001
Instrumentation, n (%)	31 (64.6)	-	-
Antibiotic duration ⩾6 weeks, n (%)	44 (91.7)	60 (81.1)	0.048
Clinical remission, n (%)	43 (89.6)	63 (85.1)	0.412
Treatment failure/recurrence, n (%)	5 (10.4)	11 (14.9)	0.356

DISCUSSION

The findings of this study demonstrate that the clinical presentation and laboratory characteristics of spondylodiscitis vary considerably according to the causative pathogen. PSD was more common in older patients and was more frequently associated with comorbid conditions such as hypertension and cardiovascular disease. These observations are consistent with previous studies reporting that degenerative changes, previous surgical procedures, and systemic diseases increase susceptibility to pyogenic spinal infections[10].

In addition, inflammatory markers such as CRP and ESR were significantly higher in patients with PSD. This finding likely reflects the more aggressive inflammatory response typically associated with acute bacterial infections. The higher frequency of previous spinal surgery in the pyogenic group may also indicate the role of postoperative infections as an important etiological factor.

Patients with TSD demonstrated higher rates of weight loss and neurological deficits. The insidious course of spinal tuberculosis often results in delayed diagnosis, allowing progressive vertebral destruction and increasing the likelihood of neurological complications[7,11]. These results highlight the importance of considering tuberculosis in the differential diagnosis of patients presenting with persistent back pain, particularly in regions where the disease remains prevalent.

In the BSD group, serological testing played a central role in diagnosis. Culture positivity was relatively limited, which is consistent with previous reports emphasizing the diagnostic value of serological tests in brucellosis[6,8,12,13]. Although the clinical course of brucellar infection is generally milder compared with other forms of spondylodiscitis, delayed diagnosis may still lead to serious complications.

Radiological findings in our cohort showed that lumbar involvement was the most common localization regardless of etiology. This observation has also been reported in previous studies evaluating spinal infections[5,14]. Abscess formation occurred more frequently in pyogenic cases, suggesting a more aggressive inflammatory process. The presence of abscesses is also an important factor influencing the decision for surgical intervention.

The results of this study emphasize the importance of an etiology-based approach in the management of spondylodiscitis. Tuberculous infections require careful neurological monitoring and early recognition of surgical indications due to their progressive nature. In brucellar infections, conservative treatment with appropriate antibiotic therapy is often sufficient when diagnosis is established early. In contrast, pyogenic infections frequently require rapid diagnosis and targeted antimicrobial therapy, and surgical treatment may be necessary when abscess formation or neurological compromise occurs.

In our cohort, surgically treated patients achieved favorable outcomes with effective infection control. The absence of implant-related complications in instrumented patients supports previous studies suggesting that spinal stabilization can be safely performed even in the presence of active infection[15-17]. In addition, continuation of antibiotic therapy for at least six weeks after clinical remission appears to contribute significantly to treatment success[18].

Although the presence of motor neurological deficits and abscess formation was higher in patients who underwent surgical treatment, the similarity of clinical remission rates compared with patients managed conservatively indicates that surgical treatment is an effective and safe option when appropriately indicated[19]. Nevertheless, conservative management was also effective in selected patients without neurological deficits or mechanical instability. Careful clinical and laboratory monitoring allowed adequate infection control in these cases without the need for surgical intervention[20].

Study Limitations

This study has several limitations. Its retrospective design and single-center setting may limit the generalizability of the findings. In addition, diagnostic approaches and treatment strategies may have changed over the 10-year study period. Culture negativity in some patients, particularly in pyogenic and brucellar infections, also limited the microbiological evaluation. Despite these limitations, the inclusion of a relatively large patient cohort and the comparative evaluation of different etiological groups represent important strengths of this study.

CONCLUSION

Spondylodiscitis is a complex spinal infection characterized by variable clinical course, inflammatory response, and neurological involvement depending on the etiological agent. While inflammatory markers are more pronounced in PSD, weight loss and neurological deficits are more frequently observed in tuberculous cases. In BSD, serological testing plays

a key role in diagnosis. In patients who underwent surgical treatment and achieved clinical and laboratory remission, successful infection control can be achieved with etiology-specific antibiotic therapy administered for at least six weeks. Early recognition of these etiology-specific differences is critical for selecting appropriate treatment strategies and preventing potential neurological complications.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Scientific Research Ethics Committee of University of Health Sciences Türkiye, Erzurum Faculty of Medicine (approval no: 2026/01-29, date: 14.01.2026).
Informed Consent: Retrospective observational study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: N.P., B.P., Concept: N.P., B.P., Design: N.P., B.P., Data Collection or Processing: N.P., B.P., Analysis or Interpretation: N.P., B.P., Literature Search: N.P., B.P., Writing: N.P., B.P.
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