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Clinical and microbiological profile of spondylodiscitis: a retrospective analysis

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Abstract

Background Spondylodiscitis is a rare infectious disease with rising incidence in recent years. From 2005 till 2021 the incidence of Spondylodiscitis rose by 104%. Given its potential to cause complications and mortality, it demands greater attention. Epidemiological data and predisposing factors can vary significantly across different geographical regions, suggesting that data from Iran may differ from those in other parts of the world. This study aims to evaluate the demographic, clinical, laboratory, and imaging characteristics of spondylodiscitis patients treated at Loghman Hakim Hospital in Tehran. Additionally, it seeks to analyze the treatment outcomes and complications associated with the disease.

Methods We conducted a retrospective analysis of 65 adult patients diagnosed with spondylodiscitis over the past decade (2012–2022). The data collected encompassed demographic characteristics, underlying diseases, clinical presentations, laboratory and radiological findings, microbiological results, treatment approaches, and outcomes.

Results The study included 65 adult patients with a mean age of 55.12 years, showing a slight male predominance (58.5%). Spondylodiscitis was community-acquired in 49.2% of cases and hospital-acquired postoperatively in 50.8%. The lumbosacral spine was the most affected region (47.4%). *Staphylococcus aureus* was the most frequently isolated microorganism (28.2%), followed by *Mycobacterium tuberculosis*. Complications included abscess formation in 49.2% of patients and multiorgan failure in 6.2%, resulting in death. Treatment primarily involved antibiotic therapy, with surgical intervention in select cases. Poor outcomes were observed in patients with unidentified microorganisms and those with longer delays in diagnosis.

Conclusions Spondylodiscitis is associated with significant morbidity and a high rate of complications, particularly in cases with delayed diagnosis. Early diagnosis, appropriate antimicrobial therapy, and surgical intervention when necessary are crucial for improving patient outcomes. This study highlights the need for ongoing research to optimize diagnostic pathways and develop long-term management strategies for spondylodiscitis.

Keywords Spondylodiscitis, Spinal Infections, Microbiological Analysis, Clinical Characteristics, Treatment Outcomes, Epidemiology, Iran

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Background

Spondylodiscitis is an infection of the vertebral body and intervertebral disc space. It is a complex disease with a multifactorial etiology, and a multidisciplinary approach is required to determine the optimal treatment. Spondylodiscitis is a rare disease accounting for 3–5% of all cases of osteomyelitis [1]. The estimated incidence in developed countries ranges from 4 to 24 cases per million annually, depending on location, time period, and study inclusion criteria [2].

The global incidence of spondylodiscitis has been increasing, particularly among aging populations. In Germany, a study reported a 104% increase in cases from 2005 to 2021, with incidence rates climbing from 5.4 to 11.0 per 100,000 individuals [3]. In-hospital mortality rates have been estimated at approximately 7.4%. In Iran, epidemiological data on spondylodiscitis are limited. However, a retrospective study conducted in Hamadan between 2006 and 2015 identified 71 cases, predominantly affecting the lumbar spine [4]. Notably, *Brucella* species were responsible for 38% of cases, followed by *Mycobacterium tuberculosis* at 15.5%. The study underscored the necessity of early diagnosis and appropriate treatment to mitigate severe complications. These findings highlight regional variations in the etiology and burden of spondylodiscitis, emphasizing the need for further epidemiological research to optimize disease management strategies.

There is evidence that the increase in the global incidence of this disease may be due to longer life expectancy in patients with chronic debilitating diseases, immunosuppressive treatment, increased use of stationary devices, and spine surgery. However, the increase may also be due to improved diagnostic methods [5, 6]. Mortality from spondylodiscitis has been reported to be less than 5% and varies between 0 and 11% [2].

Spondylodiscitis is a debilitating and often painful disease, with studies confirming that it has a significant impact on performance and quality of life. The disease significantly impacts patients' quality of life, affecting daily activities, social interactions, and psychological well-being, leading to considerable disability compared to the general population [7, 8]. This disability is caused by residual neurological deficits or persistent and severe back pain, which occurs in one-third of cases. The recurrence rate cannot be accurately determined due to insufficient follow-up periods in most studies.

It is known that reinfection occurs even years after the original treatment. In a series of 253 patients followed for an average of 6.5 years, recurrence was recorded in 14% of cases [2, 9, 10].

The disease is caused by various factors. Among the common pyogenic bacteria, *Staphylococcus aureus* and

Streptococcus viridans are the most frequent, while rare cases of *Brucella*, *Mycobacterium tuberculosis*, and fungal infections occur in certain regions [2, 11]. Several predisposing factors have also been reported: diabetes, advanced age, drug abuse, immunosuppression, cancer, renal failure, rheumatic disease, cirrhosis of the liver, and previous spinal surgery.

Due to the rarity of the disease, the insidious onset of symptoms, and the high frequency of back pain in the general population, the diagnosis is often delayed or not considered [2]. However, improved techniques for early diagnosis, appropriate antibiotic treatment, and, in some cases, surgery have reduced mortality and disability [12].

Given the advancements in diagnostic and therapeutic tools over the past decade, it is likely that the incidence, treatment response, complications, and outcomes of this disease have also evolved. However, recent studies indicate a lack of investigation into these changes.

Considering the differences in epidemiological data and predisposing factors in different geographical regions, these data may vary in Iran as well as in other parts of the world. Therefore, due to the differences in data, it is necessary to design studies to extract and analyze Iran-specific data. Hence, this study aims to investigate the demographic, clinical, laboratory, and imaging characteristics of spondylodiscitis and their relationships among patients treated at Loghman Hakim Hospital over the past decade.

Methods

All patients with spondylodiscitis admitted to Loghman Hakim University Hospital, Tehran, Iran, from January 2012 to December 2022 were included, with additional follow-up conducted this year. The diagnosis of spondylodiscitis was made on clinical, radiological, and microbiological bases. The study was approved by the hospital's ethics committee.

Patient data were collected retrospectively from hospital records. A database search was conducted to identify cases labeled as "spondylodiscitis" and misclassified cases under "spondylitis." Each case was reviewed for diagnostic accuracy, and only confirmed spondylodiscitis cases were included. Relevant clinical, laboratory, and imaging data were extracted from patient files. For follow-up, contact details were obtained from medical records, and patients were reached via phone calls to collect additional outcome data. The following information was collected for each patient: demographic characteristics, underlying diseases, clinical symptoms, invasive procedures, laboratory data, radiological images, microbiological findings, any surgical procedures, treatments, complications, and follow-up outcomes.

Some cases underwent surgical procedures. Surgical intervention was indicated for spinal instability and epidural abscesses in stages 4 and 5, particularly in patients with plegia, paresis, or sphincter dysfunction. Additionally, paravertebral abscesses were typically managed through radiological intervention, and if unsuccessful, general surgery (rather than neurosurgery) was performed.

All cases of spondylodiscitis were classified into two groups: those with previous spinal surgery (Group A) and patients without a history of spinal surgery (Group B). Patients received appropriate antimicrobial treatment according to susceptibility testing of the isolated microorganisms. Specific antibiotic therapy was administered intravenously, followed by oral treatment. If the microorganism could not be identified, empirical antibiotic treatment with a combination of meropenem and vancomycin was administered for at least 2 weeks, followed by 4 weeks of oral treatment, assuming *Staphylococcus aureus* as the primary cause. Follow-up was performed using questionnaires regarding clinical characteristics, pain control, neurological disability (using the modified Rankin scale for neurological disability), and recurrence.

Microbiological analysis of specimens was performed using conventional culture and biochemical identification methods. CT-guided bone biopsy samples in saline were cultured on blood agar, with further evaluation conducted as necessary. Identification of bacterial isolates was based on biochemical methods rather than molecular techniques. In cases where specimens were preserved in formalin, PCR was performed to detect *Mycobacterium tuberculosis*, *Brucella spp.*, and other potential pathogens when clinically suspected. For the detection of methicillin-resistant *Staphylococcus aureus* (MRSA), the disk diffusion method was used, employing cefoxitin discs to determine resistance patterns.

Data analysis

Statistical analysis was conducted using IBM-SPSS (version 27). The Chi-square test was used to examine differences between groups. Statistical significance was defined as a P-value of less than 0.05. Univariate associations were tested using relative risks (RR) and their 95% confidence intervals (CI95).

Results

Demographic

A total of 65 adult patients were treated in our hospital for spondylodiscitis between 2012 and 2022. Overall, 58.5% were male, and the average age ($\pm$ SD) was 55.12 $\pm$ 16.4 years (range 14–85). Thirty-two patients (49.2%) developed community-acquired spondylodiscitis, while 33 (50.8%) developed post-operative hospital-acquired

Table 1 Levels of Spinal involvement

	Number	Percent
Cervical	2	3.2
Thoracic	5	8.1
Lumbosacral	31	50.0
Cervical and Lumbosacral	2	3.2
Thoracic and Lumbosacral	21	33.9
Cervical, Thoracic, and Lumbosacral	1	1.6

Table 2 Comorbidities and Medical histories of Spondylodiscitis patients

	Percent
Cardiovascular diseases	36.9
Type II Diabetes	30.7
Recent or current infection	29.2
Hemodialysis	7.6
Addition to Intravenous Injected drugs	6.2
Long term Corticosteroids use	6.2
Liver Cirrhosis	1.5
HIV infection	1.5

Among the 13 patients with *Staphylococcus aureus* spondylodiscitis, several risk factors were identified. Five patients had diabetes mellitus, while four had a history of cardiovascular disease. Additionally, one patient had renal risk factors, and another had liver cirrhosis. Five patients had a concurrent or recent infection, but none had a history of intravenous drug use, HIV infection, or corticosteroid use. These findings underscore the role of underlying comorbidities in *S. aureus* spondylodiscitis and highlight the absence of certain commonly associated risk factors

spondylodiscitis. In more than half of the patients (38 patients, 58.5%), the involvement of the spine was limited to one level. However, two-level (23 patients, 35.4%) and three-level involvement (1 patient, 1.5%) were also observed. The most affected region of the spine was the lumbosacral area (31 patients, 47.4%), followed by the thoracic (5 patients, 7.7%) and cervical tracts (2 patients, 3.1%). Among patients with two-level involvement, the combination of lumbosacral and thoracic (21 patients, 32.3%) was more common than cervical and lumbosacral (2 patients, 3.1%). Finally, three-level involvement included the cervical, thoracic, and lumbosacral regions. These results are summarized in Table 1.

Risk factors

Baseline comorbidities and medical histories related to spondylodiscitis in the patients are listed in Table 2. Long-term steroid use was defined as the use of prednisolone (15–20 mg) for more than 20–30 days.

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Clinical features

The interval between diagnosis and symptom onset averaged 32.32 ± 49.40 weeks. Community-acquired (CA) spondylodiscitis was diagnosed earlier, with an average of 24.7 ± 41 weeks, compared to Hospital-acquired (HA) spondylodiscitis, which averaged 39.1 ± 55 weeks.

Table 3 presents the prevalence of various symptoms among patients. Back pain was the most common symptom, occurring in 60 patients (92.3%). Radicular pain was the second most reported symptom, with 43 occurrences (66.2%), followed by neurological deficits (50.8%). Fever (30.8%) and weight loss (21.5%) were less common.

Fever and weight loss were more prevalent in patients with CA spondylodiscitis. Back pain and radicular pain were also more common in this group, although the difference was less pronounced compared to HA spondylodiscitis.

Neurological deficits, though not significantly different, were more common in HA spondylodiscitis patients (63.6%) than in CA spondylodiscitis patients (37.5%). Among neurological deficits, paresthesia was the most common, reported in 16 patients (24.6%). Seven patients experienced plegia, a complete loss of muscle function, and 15 patients had limb paresis. Sphincter abnormalities, though less frequent, were reported in 8 patients (12%).

Table 3 Clinical features based on previous spinal surgery

	Percent
Back pain	60
Radicular pain	43
Neurological deficit	33
Fever	20
Paresthesia	16
Reduction of limb force	15
Weight loss	14
Sphincter abnormality	8

A high white blood cell (WBC) count ($> 11,000$) was found in 20% of patients. Elevated erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels (greater than 10) were observed in 78.5% and 69.2% of patients, respectively.

Complications

Unfortunately, four patients died during their hospital stay due to multiorgan failure caused by spondylodiscitis. Among the 54 patients with accessible records, 32 developed abscesses. Of these, 12 patients (18.5%) had paravertebral abscesses, 13 patients (20%) had epidural abscesses, and 7 patients (10.8%) had both types of abscesses (Table 4).

Microbiology

A causative microorganism for spondylodiscitis was identified in 63 patients (96.9%). Of these, microorganisms were isolated from biopsy in 32 patients (15 patients via CT-guided biopsy and 17 via open biopsy). Blood culture revealed the microbial etiology in 3 cases, while abscess drainage provided data for 13 patients by culture and 8 patients by smear. Note that multiple modalities were used in some patients.

The majority of spondylodiscitis cases were attributed to Gram-positive bacteria (14 isolates, 35.8%), followed by tuberculosis (10 cases, 25.6%), Gram-negative bacteria (other than *Brucella*) (9 isolates, 23.1%), and brucellosis (6 cases, 15.3%). The most frequently isolated microorganisms were *Staphylococcus aureus* (11 isolates, 28.2%), *Enterobacteriaceae* (3 isolates), non-fermenting Gram-negative bacilli (3 isolates), coagulase-negative staphylococci (2 isolates, 12.3%), and *Pseudomonas aeruginosa* (2 isolates, 12.3%). Table 5 summarizes the microorganisms' distribution.

Treatment

Culture-based therapy was employed in cases where the causative microorganism was identified and cultured. For cases with unknown etiologies, empiric therapy was utilized. Upon diagnosis, specific treatments for tuberculosis and brucellosis were administered for 24 weeks and 8 weeks, respectively. All patients received antibiotic

Table 4 Abscess formation

	Percent
Without abscess/No data	50.7%
Paravertebral Abscess	18.5%
Epidural Abscess	20.0%
Paravertebral and Epidural Abscesses	10.8%
Total	100.0%

Table 5 Microbiological etiology

Microorganisms	Community Acquired (CA)	Hospital Acquired (HA)	Total
<i>MRSA</i> ^a	2	1	3
<i>MSSA</i> ^b	4	4	8
<i>MS-CNS</i> ^c	0	1	1
<i>MR-CNS</i> ^d	0	1	1
<i>Streptococcus spp.</i>	1	0	1
<i>Pseudomonas aeruginosa</i>	0	2	2
<i>Enterobacteriaceae</i>	0	3	3
<i>NFGNB</i> ^e	3	0	3
<i>Burkholderia cepacia</i>	0	1	1
<i>Mycobacterium tuberculosis</i>	6	4	10
<i>Brucella</i>	5	1	6
Unknown	11	15	26
Total	32	33	65

^a Methicillin-resistant *Staphylococcus aureus*^b Methicillin-sensitive *Staphylococcus aureus*^c Methicillin-sensitive coagulase-negative staphylococci^d Methicillin-resistant coagulase-negative staphylococci^e Nonfermenting gram-negative bacilli include organisms such as *Pseudomonas aeruginosa* and *Burkholderia spp*

therapy, with 46.2% receiving medical treatment alone. Intravenous (IV) therapy was followed by oral therapy.

Among the 49 patients who received antibacterial treatment, excluding those with tuberculosis and brucellosis, 48 received IV therapy. Of these, 31 patients were given both gram-positive and gram-negative coverage, 15 received only gram-positive coverage, and 2 received only gram-negative coverage.

Oral therapy was administered to 36 patients, with 29 receiving both gram-negative and gram-positive coverage, 4 receiving only gram-positive coverage, and 3 receiving only gram-negative coverage. Various regimens were used to treat pyogenic spondylodiscitis caused by other bacteria.

In the group with *Staphylococcus aureus* spondylodiscitis, most strains were methicillin-susceptible, and patients were primarily treated with flucloxacillin. For methicillin-resistant strains, a vancomycin-based regimen was used.

When the etiologic agent could not be identified or presumed, empirical treatment (typically lasting 3.5 ± 3 months) primarily involved broad-spectrum antibiotics, including vancomycin $\pm$ cotrimoxazole (50%) and carbapenems (38.5%).

Intervention.

A total of 30 patients underwent surgical procedures, as listed below in Table 6 by procedure type. Procedures were performed by the neurosurgery, general surgery, or interventional radiology departments, depending on the

Table 6 Surgical procedures

Procedure	Cases
Abscess drainage	14
Interbody fusion	2
Instrumental spinal stabilization	10
Laminectomy	8
Discectomy	9
Foraminotomy	5
Fasciectomy	3
Device excision	5
Body debridement	1
Corpectomy	2

type. Note that some patients underwent more than one procedure.

Outcome

The study conducted a follow-up with 42 patients, comprising 22 with community-acquired (CA) and 20 with healthcare-associated (HA) spondylodiscitis. Nineteen patients were lost to follow-up due to unanswered calls or incorrect phone numbers, and four patients died during their hospital stay.

Among the remaining patients, two died, and 17 had poor outcomes, as indicated by Modified Rankin Scale scores of 2 or higher. Poor outcomes were observed in 11 HA patients and six CA spondylodiscitis patients. Microorganisms were not identified in 11 of the 17 patients with poor outcomes.

In total, six patients died. In two cases, death was attributed to underlying comorbidities, while four deaths were directly related to spondylodiscitis and its complications. The characteristics of these four patients included an age of over 60 years (two males, two females), with three having undergone prior surgery. Three patients had multi-region spinal involvement, affecting the thoracic and lumbosacral regions. One patient had an epidural abscess, while radicular pain and neurological deficits were present in three cases.

The treatment regimens for these 17 patients included anti-tuberculosis therapy for two, coverage for both Gram-positive and Gram-negative bacteria for 15, and coverage for only Gram-positive bacteria for six patients.

Out of the 42 patients, 24 experienced controlled pain, 11 had uncontrolled pain, and seven had relatively controlled pain.

Seventeen patients experienced a relapse, necessitating surgical intervention in all cases. The mean time to relapse was 18 weeks. Among these 17 patients, 12 had HA spondylodiscitis, and five had CA spondylodiscitis.

Twenty-nine patients continued to suffer from back pain, and 26 exhibited neurological deficit symptoms. Of the 29 patients with back pain, 14 had CA spondylodiscitis, and 15 had post-operative spondylodiscitis. Of the 26 patients with neurological deficits, 13 had CA spondylodiscitis, and 13 had post-operative spondylodiscitis.

Discussion

This study examines the clinical characteristics, microbiological profile, and outcomes of spondylodiscitis in a cohort of patients treated at Loghman Hakim Hospital over the past decade. Our findings align with existing literature, identifying spondylodiscitis as a condition predominantly affecting elderly individuals, particularly those with underlying conditions such as diabetes and immunosuppression [1, 2, 13].

The most common symptom among patients, as noted in previous studies, was low back pain. Additionally, fever and weight loss were more prevalent in community-acquired (CA) spondylodiscitis compared to healthcare-associated (HA) spondylodiscitis. In our series, spinal infections were most frequently located in the lumbar spine (47%), while neurological disorders were more common in patients with infections involving both the thoracic and lumbosacral spine [6, 14, 15].

Despite the endemic presence of brucellosis and tuberculosis in our country, the majority of patients had pyogenic spondylodiscitis (58.9%), consistent with literature reports [12, 15].

Gram-positive bacteria were more prevalent than gram-negative bacteria, with *Staphylococcus aureus* being the most commonly isolated organism (28%). The lower frequency of staphylococcal infection in our series compared to other studies may be due to only 60% of our patients having a confirmed isolated organism, likely because of prior antibiotic treatment before referral.

The second most common microorganism in our study was *Mycobacterium tuberculosis*, a finding that contrasts with a recent literature review. However, other studies have shown that tuberculosis still causes spinal infections despite extensive global vaccination programs [9, 16].

The treatment outcomes of our cohort are also consistent with existing evidence: most pyogenic spinal infections could be successfully treated using conservative measures alone (intravenous antibiotic therapy). If the patient's condition improved but baseline inflammatory biomarker levels were not achieved, oral therapy was continued after parenteral therapy.

Due to the rarity of spondylodiscitis, randomized controlled trials of antimicrobial therapy are lacking. Therefore, physicians base treatment decisions on factors such as antimicrobial activity against known or possible pathogens, bone and disc tissue penetration, and side effect

profiles. Conservative treatment, sometimes combined with surgery, has been shown to produce good results in most patients.

However, recurrence rates highlight the need for long-term follow-up, especially in patients with risk factors for recurrence. The decision to undergo surgery was based primarily on the presence of neurological deficits or spinal instability, which is consistent with current treatment guidelines.

This study reaffirms the importance of modern imaging techniques, especially magnetic resonance imaging (MRI), in the diagnosis of spondylodiscitis. MRI is crucial in identifying the extent of infection and determining the treatment plan, which is in line with the results of other studies. Despite diagnostic advances, delays in diagnosis remain a concern. Our results show that symptoms persist for several weeks on average before a final diagnosis is made, potentially contributing to higher rates of complications such as persistent pain and neuropathy.

The mortality rate observed in our study was slightly lower than in other studies, which may be due to the early intervention and multidisciplinary approach at our institution. Nevertheless, the morbidity associated with spondylodiscitis remains significant, especially the long-term impact on quality of life. This result has been confirmed in other studies that highlight the persistent nature of symptoms even after the infection has subsided.

Conclusion

This study confirms that spondylodiscitis is a serious disease associated with significant morbidity. Early diagnosis and a tailored treatment approach, encompassing both medical and surgical strategies, are crucial for improving patient outcomes. This study acknowledges several limitations that warrant discussion. Primarily, the retrospective nature of the data collection resulted in inconsistent availability of detailed clinical information related to the specific antibiotic regimens employed, including the combinations of antibiotics and their respective durations. This gap in treatment specificity restricts our ability to closely analyze how various antibiotic strategies influence patient outcomes. Furthermore, the lack of standardized follow-up data could have compromised the precision of our long-term outcome assessments, especially with respect to recurrence rates and complications. Future studies should aim to identify strategies to optimize diagnostic pathways, thereby reducing delays and minimizing the risk of recurrence. Additionally, longitudinal studies are needed to better understand the chronic impact of spondylodiscitis on patients' quality of life and to develop comprehensive treatment plans addressing both acute and long-term challenges.

Abbreviations

CA	Community-acquired
HA	Hospital-acquired
WBC	White blood cell
ESR	Erythrocyte sedimentation rate
CRP	C-reactive protein
CT-scan	Computed tomography scan
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>
MSSA	Methicillin-sensitive <i>Staphylococcus aureus</i>
MS-CNS	Methicillin-sensitive coagulase-negative staphylococci
MR-CNS	Methicillin-resistant coagulase-negative staphylococci
NFGNB	Nonfermenting gram-negative bacilli
IV	Intravenous

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Authors' contributions

IAD designed the evaluation and drafted the manuscript. GG and IH participated in designing the evaluation, performed parts of the statistical analysis, and helped to draft the manuscript. GG, IH, AA, SA, FJG, MT, and IAD collected the clinical data, interpreted them, and revised the manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. Data sharing is subject to ethical and legal considerations.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Research Medical Ethics Committee of Shahid Beheshti University of Medical Sciences (approval number: IR.SBMU.RETECH.REC.1402.758). In accordance with national regulations, formal consent to participate was deemed unnecessary for this research. All processes were carried out in compliance with institutional and ethical guidelines to ensure participant confidentiality and study integrity.

Competing interests

The authors declare no competing interests.

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