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Management of spontaneous pyogenic spondylodiscitis: a descriptive cohort study

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Abstract

Background Spontaneous spondylodiscitis (SD) is an inflammation of the vertebral endplate and the intervertebral disc with no prior surgery or intervention. The treatment of spontaneous pyogenic SD mainly consists of systemic antibiotics and rest. Some cases require surgery due to failure of medical treatment or due to neurological compromise. Due to the disease heterogeneity, there are no standardized, widely adopted treatment protocols. We conducted this study to assess the clinical outcome of the different treatment modalities.

Results This is a retrospective analysis of prospectively collected data of patients with spontaneous non-tuberculous spondylodiscitis. Thirty-eight patients were identified, including 14 males and 24 females. The mean age was 49 years. Twenty-three patients underwent surgery from the start while 15 patients received conservative medical treatment. Among the latter, 8 patients showed disease progression and required surgical intervention. The ODI/NDI at 1 year (mean = 8) was significantly better than before treatment (mean = 18). Among 11 patients with motor deficit at presentation, 8 improved and 3 remained stable. There were 14 complications, including 11 minor and 3 major, requiring one revision surgery.

Conclusions Surgical decompression and debridement with or without instrumented fusion for complicated SD cases is a safe and effective treatment modality. Close follow-up is needed in case of conservative treatment for early detection of treatment failure and disease progression. Baseline characteristic variabilities in patients with spontaneous pyogenic SD could predict conservative treatment failure, but this needs to be validated in larger series.

Keywords Spondylodiscitis, Pyogenic, Surgery, Microbiology

Background

Spondylodiscitis (SD) is a term that involves infection of the intervertebral discs, the vertebral endplates and body, with or without spread to the spinal canal [1]. The incidence of infectious SD in western societies ranges from 0.4 to 2.4/100,000 each year. This incidence is even rising due to the expanding population of elderly and immune-compromised patients as well as the increased rate of spinal surgeries [2].

In spontaneous SD, the route of infection is usually hematogenous most commonly from the genito-urinary tract, skin, soft tissues, respiratory tract, gastrointestinal tract or oral cavity [3]. On the other hand, infection may be inoculated into the disc space directly at the time of invasive spinal procedures, of which 0.1–4% are complicated by septic discitis. This accounts for 20–30% of all cases of spondylodiscitis [4]. Tuberculosis is among the most common causes of spontaneous SD worldwide, while the most common non-tuberculous organism is staph aureus accounting for almost half of cases [5]. This is followed by gram negative bacilli (Escherichia Coli), streptococci/enterococci [2]. Multiple risk factors including co-morbidities have been associated with increased risk of infectious SD, including age, diabetes mellitus, immune-suppressive therapy,

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renal failure, intra-venous drug use and hepatic cirrhosis among others [6, 7].

The most common symptom of SD is pain (90%). Fever is present in about 60% of patients. Other constitutional symptoms like weight loss and anorexia may also be seen [8]. Neurological deficit incidence vary among studies between 10–50%, this reflects the delay in diagnosis that may lead to neural compromise [9]. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are elevated in most cases while the total leukocytic count (TLC) is raised in about 50% of cases and is not as useful for follow up as the former two [6]. The most sensitive imaging modality for early detection of SD is magnetic resonance imaging (MRI). MRI also allows proper assessment of the neural elements and the presence of paraspinal pockets of infection, while computed tomography (CT) is helpful for assessment of bony destruction and to guide disc biopsy [10]. Lumbar spine is most commonly affected in non-tuberculous SD, followed by the thoracic spine then the cervical spine [3, 11]. The detection of the causative organism is not always possible although every effort should be made in this regard. Blood cultures are positive in about 50% of cases while culture from CT guided biopsy can reveal an organism in up to 70% of cases. But the yield of both blood cultures and CT guided biopsy is dramatically reduced in patients already receiving antibiotics [12]. The spread of infection may lead to structural collapse and subsequent kyphosis with or without neural compromise. Another cause of neural compromise is epidural abscess. Chronic illness and diabetes increase the risk of epidural extension [13]. The degree of neurological deficit is greater than that expected by the mechanical compression alone which suggests a vascular compromise as well [8].

The mainstay of treatment of SD is antimicrobial therapy. The choice of antibiotics should depend primarily on the culture results. If no growth was identified, empirical antibiotics are used. The duration varies widely among studies, but a minimum of 8–12 weeks is usually required to decrease the chances of relapse [6, 12, 14]. ESR and CRP are useful ways to monitor treatment response as well as clinical picture. A decrease of CRP by 50% or more together with the reduction of pain and absence of neurological deficit is a good indication to switch to oral therapy [3] . Surgery is usually indicated in case of neurological compromise, progressive deformity, persistent severe pain, or drainage of epidural abscess. In addition to neural decompression and spinal stabilization, surgery has the advantage of obtaining open biopsy (has a better bacterial yield) and, in some cases, may lead to earlier mobilization [15–17].

Methods

This is a retrospective review of the prospective registry of spine infections patients treated at Ain Shams University Hospitals from 2019 to 2021. We included patients 18 years and above, from both sexes diagnosed with spontaneous spondylodiscitis based on their clinical, radiological and laboratory data. Spontaneous SD means: SD that occurred in patients without previous spine surgery or percutaneous procedures. The diagnosis of spondylodiscitis was based on a history of at least significant axial back/neck pain together with an MRI showing abnormal fluid hyperintense signal of at least one disc space with irregular adjacent endplate and subchondral edema. The presence of epidural abscess/collection and deformity was recorded if present. Inflammatory markers such as ESR, CRP and TLC were also recorded. An elevated initial CRP was necessary for the diagnosis as well. Patients with tuberculous SD were excluded due to different natural history and prolonged treatment course. Patients' demographics, comorbidities, clinical, radiological and operative data were reviewed at the start of therapy and at intervals with a minimum of 1 year follow up period. Resolution of the disease was considered when there was symptomatic improvement, normalization of ESR and CRP, and at least one follow-up MRI showing resolution of the radiological stigmata of the disease. The pain intensity was objectified using the visual analogue scale (VAS) on a scale of 1 to 10, where 1 is a very trivial pain and 10 being the most severe pain "you can ever imagine". The VAS was used to in assess pain during hospital admission and subsequent clinic visits. The Oswestry disability index (ODI) questionnaire was used to assess the level of disability at the start of treatment and at 1 year post-treatment. The version of ODI used is the one available on the American Academy of Orthopedic Surgeons (AAOS) website [18]. This is an English version, and it was asked in Arabic by the resident or the surgeon who also wrote down the score. The questionnaire consists of 10 items, each item consists of a question and 6 possible answers in which the first answer is scored 0 and subsequent answers are scored 1,2,3,4 and 5, respectively. Thus, the minimum possible score for each item is 0 while the maximum is 5 (see Table 1). Based on the sum of the score of the 10 items, a final score was given. The final score is interpreted into a level of disability according to Table 1. Similarly, the neck disability index (NDI), which is a modified form of the ODI made for neck and upper back pain, was used in patients with cervical and upper dorsal disease [19]. The neck disability index has a similar scoring system and total score as the ODI. Patients with missing primary objective data (ODI/NDI) were excluded.

Table 1 Level of disability based on Oswestry disability index score and the neck disability index score

Score	Level of disability
0–4	No disability
5–14	Mild disability
15–24	Moderate disability
25–34	Severe disability
35—50	Completely disabled

This is a descriptive study; in each case, the decision to proceed with either conservative medical or surgical treatment was decided by the treating physician based on his view of the most appropriate treatment protocol. Nevertheless, we analyzed these assignment decisions based on the pre-treatment patient condition. Statistical analyses were made on GraphPad Prism software (Dotmatics, San Diego, CA, USA). Continuous data were represented using mean and standard deviation and compared using a paired t-test. Categorical data were compared using a two-tailed Fisher's exact test.

Results

Thirty-eight patients were identified and included in the study. There were 14 males and 24 females. The mean age was 49 (range 22–70). The pre-treatment demographic, clinical and radiological data are summarized in Table 2. Twenty-three patients underwent surgical treatment from the start, while 15 patients were started on medical treatment with bed rest and antibiotics. The choice between starting the patient on conservative medical treatment or surgical treatment was based on the treating surgeon's decision. The presence of motor deficit, epidural abscess, and kyphosis at presentation, were associated with assigning patients to the surgical group rather than starting medical treatment alone ($p=0.002$, 0.0001 and 0.01, respectively). In fact, all patients treated surgically from the start had at least one of these findings: epidural abscess, significant spinal deformity, or neurological deficit from the start. The mean baseline CRP in the medical group (53 mg/L) was lower than the mean of baseline CRP in the surgical group (72 mg/L), but this was not statistically significant ($p=0.1$). The baseline ODI/NDI was significantly higher in the surgical group than in the medical group ($p=0.0002$). Similarly, the mean baseline VAS was significantly higher in the surgical group than in the medical group ($p=0.0001$), see Table 6. In total, twenty-three patients were operated from the start, while among 15 patients assigned to the medical group, 8 patients (53%) experienced deterioration within weeks 2 to 4. The deterioration was in the form of increased pain to visual analogue score (VAS) of 10 alone (1 patient), development of new motor deficit (4 patients) or increased kyphosis with or without increased pain on serial imaging (3 patients).

Empirical antibiotics were used for all patients at the start of treatment. The standard combination of antibiotics used was vancomycin (1 gm intravenous every 12 h) and meropenem (1 gm intravenous every 8 h). In cases were bacteriology report revealed a specific organism, the antibiotic sensitivity test was used to determine the most appropriate antibiotic and the latter was given accordingly. The intravenous (IV) antibiotics were continued during hospital stay for a standard of 4 weeks except in the following situation: Patients who underwent surgical debridement and their CRP was decreased by > 50% of baseline before the end of 4 weeks of IV antibiotics, were switched to oral antibiotics. The average duration of IV antibiotic therapy in surgically treated patients from the start ($n=23$) was 3.2 weeks (range 2–6 weeks). The average duration of IV antibiotic therapy in patients who were conservatively treated, including those who were later operated ($n=15$), was 4.6 weeks (range 3–6 weeks). Only one patient among the conservative group was given only 3 weeks of IV antibiotics; this patient was 52 years old, had no comorbidities, had a relatively mild disease affecting L5-S1, and his initial CRP was 24 mg/L.

All patients received oral antibiotics after the IV therapy. Patients who had a negative culture and sensitivity (or in which no biopsy was obtained), were given a combination of oral antibiotics. This combination consisted of Linezolid (600 mg orally every 12 h) and ciprofloxacin (500 mg orally every 12 h) to complete a full course of 6–8 weeks. Again, this duration was shorter in patients who showed normalization of CRP, significant improvement of symptoms, and radiological resolution. Table 3 summarizes the duration of antibiotic therapy. Additionally, 3 patients, with no growth on culture, and who were at risk for brucellosis (in contact with livestock), were additionally given vibramycin (100 mg PO twice daily) for 6 weeks. C-reactive protein was used to monitor treatment response at frequent intervals during hospital stay and then at 8 weeks. Complete blood counts were also monitored. Microbiological identification of the causative organism was achieved in 55% of patients. The most common infectious agent was Staphylococcus Aureus (26%) and Escherichia Coli (16%), while 37% of patients showed no growth and the data was missing in 8% of patients (Table 2**).** Among conservatively treated patients, 3 underwent a CT guided biopsy to identify the causative organism. The latter was identified in 2 of these patients.

In total, 31 patients underwent surgery. All surgical procedures entailed a vigorous surgical debridement and

Table 2 Pretreatment demographic and clinical data

	Surgical from the start	Medical only	Medical switched to surgical	Total
Number	23	7	8	38
Mean age in years (range)	45	46	53.4	49 (22–70)
Male (%)	35%	57%	25%	14 (37%)
Female (%)	65%	43%	75%	24 (63%)
Diabetes Mellitus	10	3	3	16 (42%)
Active infection elsewhere	5	0	3	7 (18%)
End stage renal disease (ESRD)	3	2	1	6 (16%)
No relevant comorbidities	3	2	0	5 (13%)
Presentation				
Axial pain	23 (100%)	7 (100%|)	8 (100%)	38 (100%)
Axial pain VAS (Mean)	8.8/10	6.6/10	7.25/10	8/10
Radicular pain	7 (30%)	4 (57%)	3 (37.5%)	15 (40%)
Motor deficit	11 (48%)	0 (0%)	0 (0%)	11 (29%)
Mean ODI	24	8	11.4	18
Mean TLC (× 1000/ µL)	11.35	10	10.63	11
Mean CRP level (mg/L)	72	30	73	65
Cervical disease	4 (17.5%)	1 (14%)	0 (0%)	5 (13%)
Thoracic disease	15 (65%)	1 (14%)	5 (62.5%)	21 (55%)
Lumbar disease	4 (17.5%)	5 (71.5%)	3 (37.5%)	12 (32%)
Presence of epidural abscess	19 (82%)	1 (14%)	1 (12.5%)	22 (58%)
Presence of kyphosis	12 (52%)	0 (0%)	5 (62.5%)*	17 (45%)
Staph aureus	7	1	2	10 (26.5%)
Escherichia coli	5	0	1	6 (16%)
Streptococcus viridans		2	0	2 (5%)
Staphylococcus epidermidis	2	0	0	2 (5%)
Bacteroides fragilis	1	0	0	1 (2.5%)
No organism identified	8	1	5	14 (37%)
Microbiological data not available	0	3	0	3 (8%)

VAS visual analogue scale, *ODI* Oswestry disability index, *CRP* C reactive protein, *TLC* total leukocytic count

* 4 out of 5 had mild kyphosis

washout of infection, followed by decompression of the neural elements with or without instrumented fusion. In all cases, the disc was debrided either through a direct posterior approach (lumbar levels), posterolateral transpedicular or extra-cavitary approach and anterolateral retro-pleural approach (thoracic levels) or anterior approach (cervical levels). In 26 patients (84%), instrumented fusion was added. The type of surgical approach and fusion technique is summarized in Table 4.

There were 14 complications in the surgical group including 11 minor and 3 major complications requiring one hardware revision surgery, one pig-tail catheter insertion for residual psoas abscess and one ICU admission for acute hepatitis with ascites (in a patient with pre-existing liver disease). A complete list of complications is shown in Table 5.

At 8 weeks after the start of all treatments, the mean CRP was 10 mg/L compared to 64 mg/L before treatment ($p < 0.05$). Three cases had a CRP of 48 mg/L or higher at 8 weeks. These cases included 2 cases with psoas abscess and one case that underwent revision surgery for mal-positioned hardware. The post-treatment CRP in surgical group (12 mg/L) did not significantly differ from that of the medical group (9 mg/L) [$p = 0.5$]. The total white blood cell (TLC) after treatment (mean $8.66 \times 1000/\mu L$) differed significantly from

Table 3 Duration of antibiotic therapy

	Surgical treatment	Medical treatment	Comparison *P* value (*t* test)	All patients
Average duration of intravenous antibiotics in weeks (range)	3.2 (2–6)	4.7 (3–6)	$p = 0.0001$	3.8 (2–6)
Average duration of oral antibiotics in weeks (range)	6 (4–10)	6.1 (4–12)	$P = 0.9$	6.1 (4–12)
Average total duration of antibiotic therapy	9.3 (7–16)	10.8 (7–18)	$P = 0.07$	9.8 (7–18)

Table 4 Surgical approaches and fusion technique

Approach	Fusion	Number of patients
Posterior laminectomy and discectomy*	None	5
Posterior laminectomy and discectomy*	Transpedicular screws and rods	15
Posterior laminectomy + costo-transversectomy	Transpedicular screws and rods	3
Posterior laminectomy and discectomy + extra-cavitary evacuation of psoas abscess	Transpedicular screws and rods	1
Anterolateral retro-pleural discectomy	Corporeal plate and screws	1
Anterolateral retro-pleural discectomy + corpectomy	Pyramesh replacement + corporeal plate and screws	1
Anterolateral retro-peritoneal approach and T10 corpectomy	Pyramesh replacement + corporeal plate and screws	1
Anterior cervical corpectomy	Expandable cage + plate and screws	1
Anterior cervical discectomy	PEEK cage	1
Anterior cervical discectomy	PEEK cage + anterior plate and screws	2

*In the lumbar levels, discectomy was done through a direct approach while in the thoracic levels, discectomy was done through a transpedicular approach

Table 5 Complications

Complications (*n*)	Management	Outcome
Incidental dural tear (6)	Primary repair*	No leak
Wound seroma (3)	Frequent dressing	Healed
Excessive bleeding (2)	Blood transfusion (2)—ICU admission (1)	Recovered
Mal-positioned hardware (1)**	Revision surgery	Proper positioning
Residual infection (1)	Pig-tail insertion for residual psoas abscess	Long recovery time
Medical complications (1)	Acute hepatitis requiring ICU admission	Long recovery time

*All primary dura repair was done using autogenic grafts (muscle, fascia)

**Anterior cervical plate needed revision for repositioning pre-treatment TLC (mean 10.95 × 1000/ μL) [$p < 0.001$] (Table 6).

In the surgical group, the mean pre-treatment ODI/NDI was 24 (moderate disability), while the 1-year post-treatment mean value was 10 (mild disability). The change in the surgical group was highly statistically significant ($p = 0.0001$). In the medical group (including crossover cases), the mean pre-treatment ODI was 9.7 (mild disability), while the 1-year post-treatment mean value was 5.6 (mild disability). The change was not statistically significant ($p = 0.09$) (see Table 6). There was no significant difference in primary outcome (ODI/NDI) at 1 year between the surgical and the medical group ($p = 0.285$). 3 patients had the same level of disability before and after treatment, these include 2 patients who were completely disabled with paraplegia and one patient who was severely disabled with motor power grade 3 in both lower limbs before the start of treatment. These patients remained with same disability level after treatment. Only one patient's level of disability worsened at 1 year; this is a patient who initially had minimal disability due to spondylodiscitis at L3,4 level with low back pain and right sciatic pain. She was started on medical treatment in the form of bed rest and antibiotics, then at 4 weeks into her treatment she developed increased pain with right partial foot drop. She underwent urgent surgery in which decompression and debridement were done. Her pain improved but her motor deficit did not. She remained with an ODI of 16 (moderate disability) at 1 year compared to an ODI of 4 (no disability) at presentation (Table 6). The change in pre-treatment VAS compared to the 1-year post-treatment was statistically significant in both the surgical and medical groups, see Table 6. The mean duration of hospital stay in the medical group was 25.7 days (range 14–51), while the mean duration of hospital stay in the surgical group was 20.5 days (range 13–43), the difference was not statistically significant ($p = 0.1$).

Discussion

Despite advances in diagnostics, antibiotic therapy and surgical techniques; infectious spondylodiscitis remains a challenging condition. First, a delay in diagnosis may be attributed to pain initially mistaken as degenerative spine disease or masked by the manifestations of the primary source of infection [20]. Second, once the clinical and radiological diagnosis is established, the microbiological diagnosis is not always reached. Even when obtaining tissue biopsy and blood cultures, many cases remain without bacterial identification leading to protracted courses of broad-spectrum antibiotics [21]. In our series, the causative organism was identified in about 55% of cases leading to change in antibiotic strategy to an organism specific antibiotic. The incidence of various microorganisms in our series was in consensus with previous reports with Staphylococcus Aureus being the most frequent organism followed by Escherichia Coli with other organisms occurring much less frequently. The relatively high rate of lack of bacterial identification (37%) is mostly attributed to antibiotic therapy given to patients before identification of organism. These are usually prescribed by the referring physician thinking that this will slow the bacterial growth. We believe that bacterial identification is so important that it justifies a delay in the initiation antibiotic therapy[12].

Table 6 Primary and secondary outcomes

Outcome	Surgical ($n = 23$)	Medical ($n = 15$)	Comparison *p* value between groups (*t* test)	All patients ($n = 38$)
Mean ODI (before treatment)	24	9.7	0.0002	18
Mean ODI (1 year)	10	5.6	0.285	8
Comparison p value	0.0015	0.09	-	
Mean VAS (before treatment)	8.8	6.9	0.0001	8
Mean VAS (1 year)	2.1	2.2	0.81	2
Comparison *P* value	0.0001	0.0001	-	
Mean CRP in mg/L (before treatment)	72	53	0.1	64
Mean CRP in mg/L (8 weeks)	12	9	0.5	10
Mean TLC count × 1000/ μL (before treatment)	11.34	10.33	0.16	10.95
Mean TLC count × 1000/ μL [8 weeks]	8.78	8.46	0.4	8.66
Average total hospital stay (days) *	20.5	25.7	0.1	22.5

ODI Oswestry disability index, *VAS* visual analogue scale, *CRP* C reactive protein, *TLC* total leukocytic count

*Total inpatient days including any subsequent hospitalization related to the main diagnosis of spondylodiscitis and including days spent at other departments (e.g., ICU, nephrology, internal medicine) to treat conditions associated with main diagnosis

Non-specific laboratory investigations have shown to be an important initial step to establish an inflammatory diagnosis. C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are elevated in almost all cases of acute spondylodiscitis [22]. In our study, CRP was a reliable albeit non-specific indicator of infection (highly positive in all cases) and correlated with treatment response with CRP level at 8 weeks of treatment showing a significant decrease compared to pre-treatment levels. Interestingly, we found that the baseline CRP in the group that started medical treatment then had to be switched to surgical treatment (mean baseline CRP = 73) was significantly higher than that of the group which started and successfully continued conservative medical treatment (mean baseline CRP = 30) ($p = 0.036$). White blood cell count on the other hand was high normal to slightly elevated (mean 10,950 cells/μL) and, while the total TLC at 8 weeks of treatment was significantly lower (mean 8660 cells/ μL) than pre-treatment levels, the difference is not considered clinically significant and therefore not as useful as CRP.

Despite some general therapeutic guidelines, the treatment of spondylodiscitis is not standard and is subject to surgeon-related variability [23]. Classically, the treatment consisted of a long course of antibiotics, rest and orthosis. Surgical debridement and stabilization are reserved for cases with neurological compromise, instability and failure of antibiotics to improve the condition. But the threshold for performing surgery is gradually diminishing owing to improved diagnosis of conservative treatment failures and an expanding array of surgical techniques. A systematic review by Rutges and colleagues, reported a rate of conversion from conservative to surgical treatment of about 25–55% of cases in a few studies that mentioned this particular scenario [21]. In our series, 23 patients (60%) underwent surgery from the start, while an additional 8 patients (21% of the total and 53% of the conservative group) required surgery due to failure of conservative treatment alone. This relatively high surgical intervention rate may simply reflect the type of patients referred to tertiary neurosurgical center who usually have a more severe disease.

We found clear indications of more severe disease at baseline among the patients who were surgically treated from the start, that included higher levels of disability by ODI scale and axial pain by VAS score. While both groups ended up doing better, with no significant difference in primary outcome at 1 year post-treatment.

Looking back at the patients who were started on conservative medical treatment then switched to surgical treatment due to disease progression, we tried to find predictors of failure in their baseline characteristics compared to those who successfully continued their conservative medical treatment. Although their overall number was small, but some differences stood out. They were slightly older (mean 53.4 vs. 46 years) and had more thoracic spine affection (5/8 vs. 1/7), but these were not statistically significant. Only one difference was statistically significant: baseline CRP, which was significantly higher in the cross-over patients (73 mg/L vs 31 mg/L, $p = 0.01$). Other characteristics we looked at included the presence of diabetes, end-stage renal disease, and baseline level of disability, but none of them was statistically significant (Table 7).

The aim of surgical intervention is mainly debridement and decompression of neurological structures with or without instrumented stabilization. To the best of our knowledge no randomized controlled trials compared conservative versus surgical treatment for pyogenic SD [24]. The latter is probably justified in cases of acute neurological compression and progressive deformity where the surgical indication is clear. But the choice is less clear in uncomplicated SD cases who present mainly with pain and minimal bone destruction. A few retrospective

Table 7 Comparison of basic characteristics of patients who succeeded versus those who failed conservative medical treatment

	Successful conservative treatment	Failed conservative treatment	Comparison *p* value
Number of patients (*n*)	7	8	–
Mean age	46	53.4	0.3
Diabetes	3	3	1
ESRD	2	1	0.5
Identifiable source of infection	0	3	0.2
Mean baseline ODI	7.4	11.4	0.37
Mean baseline VAS	6.6	7.25	0.21
Thoracic affection	1	5	0.1
Mean baseline CRP	30.9	73	0.01

ESRD end stage renal disease, *ODI* Oswestry disability index, *VAS* visual analogue score, *CRP* C reactive protein studies directly compared conservative medical treatment to surgical treatment for spontaneous SD, and the conclusions were variable. Lee and colleagues advocated early surgical decompression with or without instrumentation among the elderly patients [7]. Both Karadimas and Valancius work, showed that conservative treatment was safe and effective in the majority of uncomplicated patients, no statistical analysis was made [25, 26]. On the other hand, Nastro and colleagues compared a less invasive surgical approach (percutaneous fixation) with thoracolumbar orthosis and found that the former lead to a better outcome in the first 6 months of treatment but the difference was not significant at 9 months [27]. Even large systematic reviews came up with different conclusions. A systematic review with meta-analysis by Wang and colleagues pooled data from 1980 through 2016 and found that data neither support nor oppose surgical intervention in "all" cases of SD, while they emphasized the importance of surgical intervention in the setting of neurological deficit [28]. A recent systematic review with meta-analysis, that pooled data of 10,954 patients from 21 studies showed a significant advantage of early surgery versus conservative treatment in terms of mortality, morbidity and days of hospital stay [24]. In our study, all uncomplicated cases were started on conservative treatment with antibiotic, rest and orthosis and only those who became complicated were operated in agreement with the commonly accepted surgical paradigm. We found that patients with higher baseline CRP, possibly indicating more aggressive infection, were more likely to cross over to the surgical group. We also noticed a trend for thoracic spine affected patients to require surgery as compared to lumbar spine affected patients. We were also able to demonstrate that in the surgical group, the duration of IV antibiotic therapy was significantly shorter than that in the conservative group. As for the duration of hospital stay, we found a shorter mean duration in the surgical group but without statistical significance. In truth, the duration of hospital stay, at least at our institution, is affected by many confounding factors including the lack of outpatient infusion therapy facilities, leading to unnecessary days of hospital stay just to receive IV antibiotics.

In our study, we reported prospectively collected data eliminating the recall bias of retrospective studies. Additionally, we used objective outcome tools including the Oswestry disability index, the neck disability index and the visual analogue scale. We were able to demonstrate that our general approach of therapy, consisting of conservative therapy with close follow-up for uncomplicated SD cases and surgical treatment for complicated ones, was effective in improving patients' outcomes. On the other hand, our study had clear weaknesses. The relatively small number of patients was insufficient to derive representative demographic and clinical data. Also, the descriptive nature of the study had inherent selection bias where the choice of treatment relied on the treating physician. Nonetheless, this was relatively reduced through a "quasi" standardized approach to decision making. Finally, the choice of operative techniques was solely determined by the treating surgeon and hence no comparison could be made between different surgical approaches.

There is no doubt that a randomized controlled trial (RCT) is needed to better answer questions regarding treatment approach in patients with spontaneous non-tuberculous SD. In our study, the differences in baseline characteristics among groups at the start of treatment at one side and the finding that patients who were started on medical treatment and ended up crossing over to the surgery probably had more severe disease on the other side, are probably helpful in designing such a RCT.

Conclusions

Infectious spondylodiscitis remains a diagnostic and therapeutic challenge. In uncomplicated cases, medical treatment with systemic antibiotics and rest is usually initiated, but a close follow-up should be maintained to detect treatment failures and disease progression. It would be interesting to look in larger case series at the possible predictors of medical treatment failure including baseline CRP, spinal level of affection and baseline co-morbidities. On the other hand, patients with initial instability, progressive deformity and neurological deficit due to active neural compression are candidates for surgical debridement and decompression, with or without instrumented fusion. In our series as well as in many reported series, instrumentation did not seem to increase the risk of lingering infection. The duration of antibiotic therapy and the choice of surgical approach are not well established. Randomized controlled trials are needed to address these issues.

Abbreviations

AAOS	American Academy of Orthopedic Surgeons
CRP	C-reactive protein
CT	Computed tomography
DVT	Deep venous thrombosis
ESR	Erythrocyte sedimentation rate
ICU	Intensive care unit
IV	Intravenous
MRI	Magnetic resonance imaging
NDI	Neck disability index
ODI	Oswestry disability index
RCT	Randomized controlled trial
SD	Spondylodiscitis
TLC	Total leukocytic count
VAS	Visual analogue scale

Author contributions

AI was involved in the data analysis and drafting of the manuscript. KE contributed to the critical review of the paper and drafting of manuscript. MARA assisted in the study design, data collection, and critical review of manuscript. AEG was involved in the study design, data collection and critical review of manuscript. SH contributed to the concept, study design, data collection, critical revision of manuscript, and general supervision of the study. The authors would like to thank Dr Mohamed Tarek for helping in data collection and tabulation.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author in the form of digital excel sheets containing all the data and are available on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by Ain Shams University Faculty of Medicine Research Ethics Committee (FWA 000017585) on 25/2/2023. Approval # FAMSU R38/2023. An informed written consent to participate in the study was obtained from all participants.

Consent for publication

Consent for publication is not applicable as the study manuscript does not contain any individual person's data.

Inform consent

All authors reviewed and agreed on the final version of this manuscript and gave consent for publication.

Competing interests

The authors declare that they have no competing interests.

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