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Idiopathic pyogenic thoracic and lumbar spondylodiscitis: outcome of long segment fixation

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Abstract

Background Spondylodiscitis is an infection of the vertebral body extending to the intervertebral disc, and possibly the surrounding paraspinal structures.

Objectives To evaluate the clinical results of posterior long segment transpedicular screws fixation and decompression of the infected area for management of idiopathic pyogenic spondylodiscitis of the thoracic and lumbar spine.

Methods This retrospective study included 14 patients with idiopathic active pyogenic spondylodiscitis of the lumber and thoracic spine between January 2017 and December 2021, with follow-up continuing until December 2022. All patients had posterior long-segment rigid fixation with infection decompression.

Results All patients after 6-month follow-up had achieved complete fusion. There was no evidence of postoperative wound infection, and no patient had a recurrence of infection at the lesion site during follow-up. Prior to surgery, the mean VAS score for back pain was 7.6 (range 6–9), however, after surgery, it fell to 1.3 (0–3), a statistically significant improvement ($P < 0.001$) during the last follow-up. According to the Kirkaldy-Willis criteria, the functional prognosis was excellent in 11 individuals, good in two, and fair in one.

Conclusions Posterior long-segment fixation in conjunction with decompression of the affected area effectively resolved bacterial spinal infection and restored neurological impairment.

Keywords Decompression, Fixation, Spondylodiscitis, Thoracolumbar spine, Transpedicular screws, Epidural abscess, Long segment, Osteomyelitis, Debridement

Introduction

Spondylodiscitis is an infection of the vertebral body extending to the intervertebral disc, and possibly the surrounding paraspinal structures [1]. According to the causative organism, spondylodiscitis may be either pyogenic (caused by bacterial infections), granulomatous (caused by tuberculosis or fungal infection), or parasitic infections as (Echinococcosis) [2]. Pyogenic idiopathic or hematogenous spondylodiscitis is often caused by bacteremia transmitted from the skin, genitourinary tract, respiratory system, oral cavity, or gastrointestinal tract. Adult discs are avascular structures, and infection starts when the adjacent metaphyseal end-arterial arcades are colonized by blood borne organisms. The infection then extends directly into the disc when it breaches the endplate or to the epidural space causing an epidural abscess, or to the paravertebral subligamentous area causing paravertebral abscess. The infection may affect contiguous vertebral segments [3].

Spondylodiscitis accounts for 2% to 7% of all infections of the musculoskeletal system with an incidence estimated to be around 1/100,000 people per year, with

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a male prevalence which is double that of females (2:1). The prevalence of this infection appears to be increasing, potentially due to a rise in the number of elderly and immunocompromised individuals, along with an increase in intravenous drug abuse among the population. Clinical manifestations often begin in the fourth to fifth decades of life [4]. The lumbar spine is the most commonly affected region compromising 58% of cases, followed by the thoracic spine in 30% of cases and the least affected is the cervical spine constituting 12% of the patients [5]. Staphylococcus aureus is the most often encountered bacteria (40–80%), followed by Gram negative bacilli and streptococci/enterococci [3].

Patients with idiopathic pyogenic spondylodiscitis present clinically with unspecific insidious complaints. The main symptom is severe back pain that is localized to spine, exaggerated by axial movement, and may radiate to leg, hip, the abdomen, groin, scrotum, or perineum. 50–93% of patients present with radicular manifestations. While the main signs include spasm and tenderness of paravertebral muscles with spine motion limitation. The development of an epidural abscess or a kyphotic collapse of the affected segments may cause spinal cord or nerve roots compression resulting in neurologic deficits [6].

The increase in erythrocytic sedimentation rate (ESR) and C-reactive protein (CRP), while not pathognomonic, can serve as valuable indicators in both the diagnosis and ongoing assessment of treatment response. Magnetic resonance imaging (MRI) stands out as the most precise radiological modality for detecting spondylodiscitis, boasting a remarkable sensitivity (96%) and specificity (94%). Moreover, MRI allows for the visualization of intricate details pertaining to the epidural space, neurological structures, and paraspinal anatomy [7, 8].

Typically, individuals with spondylodiscitis undergo conservative management involving extended courses of antibiotics, prolonged bed rest, and the use of spinal bracing. Surgical intervention is frequently recommended for patients who exhibit inadequate responses to medical treatment, experience unrelenting severe pain, present with neurological deficits, harbor an epidural abscess, or display unstable deformities [9].

The objective of surgical intervention is to safeguard neurological function and attain secure bone fusion without significant deformity. The optimal surgical technique remains a subject of debate. Historically, since the 1950s, the widely accepted surgical approach for addressing spinal infections involved a radical debridement of the infection, followed by bone fusion through the use of autologous strut bone grafting, which has been considered the gold standard [10]. Anterior lumbar interbody fusion (ALIF) remains the most commonly performed operation. Although it has demonstrated high rates of infection clearance and successful bone fusion, this approach comes with notable morbidity and a heightened risk of complications related to the wound, peritoneum, and vasculature. Some authors have shared their experiences employing alternative posterior approaches, such as posterolateral (PLF), posterior interbody fusion (PLIF), and extreme lateral interbody fusion (XLIF), involving debridement, bone grafting, and fixation [11–14].

Objectives

To evaluate the clinical results of posterior long segment transpedicular screws fixation and decompression of the infected area for management of idiopathic pyogenic spondylodiscitis of the thoracic and lumbar spine.

Methods

This retrospective case series study contained 14 consecutive patients with idiopathic active pyogenic spondylodiscitis of the spine in the thoracic and lumbar region who were managed surgically in the department of neurosurgery Menoufia University Hospital, between January 2017 and December 2021. The study was approved by the local ethical scientific committee of the Menoufia Faculty of Medicine, Menoufia, Egypt (ID 5/2022NEUS 7).

We reviewed the data of all patients including the perioperative clinical assessment and radiological data, which included plain radiographs (X ray) and magnetic resonance imaging (MRI). As well as the laboratory investigations including white blood cell count (WBC), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR).

All patients had clinical manifestations suggesting spondylodiscitis such as severe back pain, painful dorsiflexion of the spine, fever, radiating pain and neurological deficits. That diagnosis was confirmed by the radiological pictures of spondylodiscitis on MRI of thoracic and lumbar spine; where vertebral bodies and intervertebral discs were hypointense in T1-weighted images and hyperintense in T2-weighted images. Plain radiographs of thoracolumbar spine showed a narrowing of the disc space at the affected level, as well as adjacent endplate sclerosis and erosion. Laboratory tests also revealed persistent high levels of WBC, CRP and ESR.

Patients were initially managed conservatively in the form of prolonged bed rest and spinal bracing, long-term antibiotics; two bactericidal and synergistic antibiotics were administered intravenously in high doses: mostly Vancomycin 1 gm vial / 12 h IV and third generation cephalosporin, cefoperazone 1 gm vial/12 IV. The duration of treatment was determined by the clinical

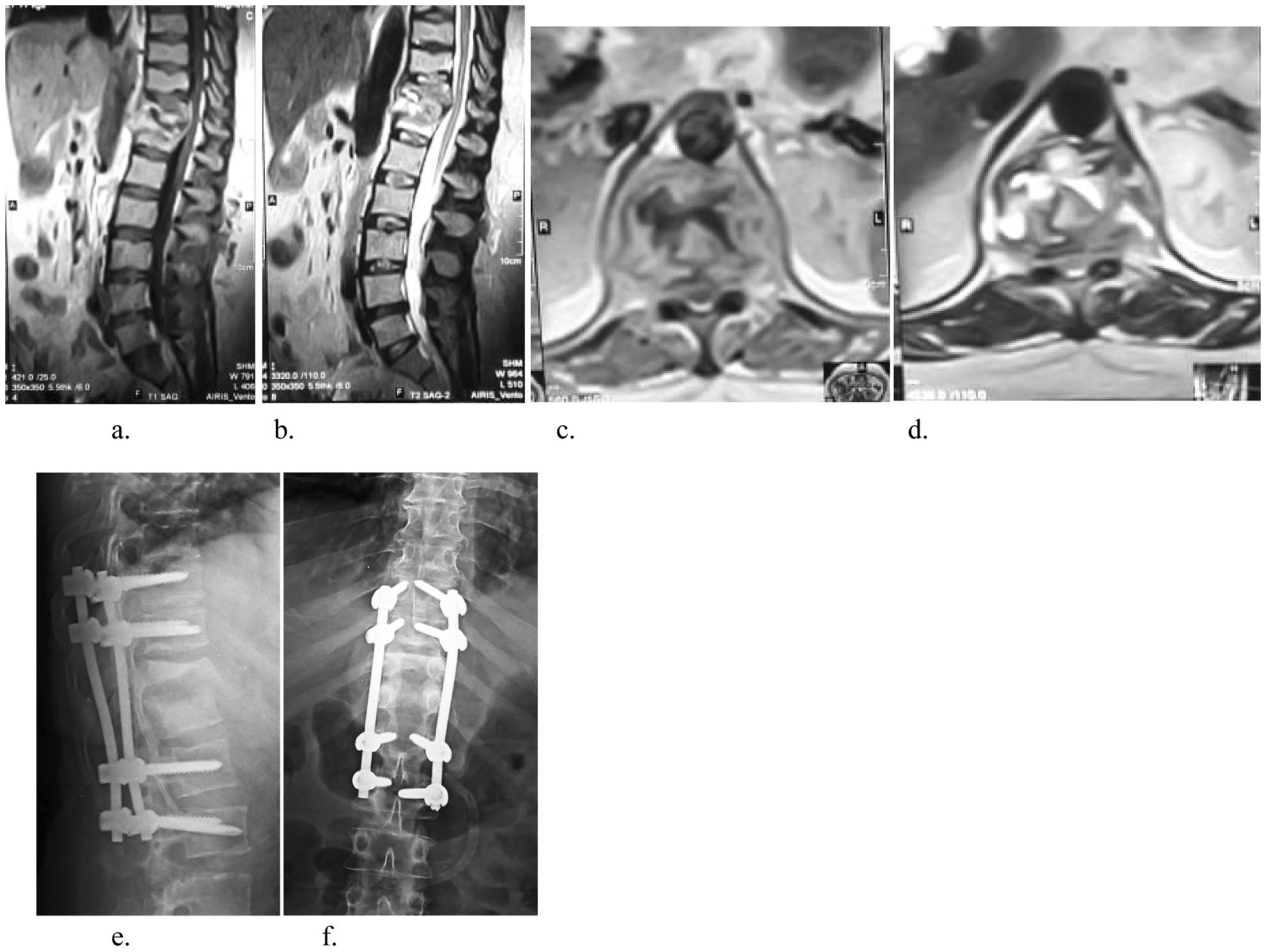

Fig. 1 D11-12 spondylodiscitis. **a**–**d** Preoperative MRI of the thoracolumbar spine showing D11-12 spondylodiscitis. **e**, **f** Postoperative antero-posterior and lateral radiographs showing D9,10–L1,2 posterior trans-pedicular screw fixation

progress, the levels of the ESR and the C-reactive protein. Mostly, the antibiotics were administered intravenously for 6 weeks, and orally for 6 weeks. Only after failure of the conservative treatment or progression of the neurological deficit or intractable pain or development of instability, was the surgical alternative afforded.

Inclusion criteria

1. Patients with clinical and radiological evidence of idiopathic spondylodiscitis, who failed to respond to conservative therapy.
2. Idiopathic spondylodiscitis patients with acute intractable pain, developing bone collapse or instability, and/or signs of neurological deficits, were indicated for initial surgery.

Exclusion criteria

1. Postoperative spondylodiscitis patients were excluded.
2. Patients with late sequelae of spondylodiscitis, such as stenosis or deformity without active infection, were excluded.

Six patients (6/14, 43%) of idiopathic active pyogenic spondylodiscitis of the spine in the thoracic and lumbar region, presented with acute intractable pain, bone collapse or instability, and/or neurological deficits and were referred for initial urgent surgical intervention. The other eight patients (8/14, 57%) of idiopathic pyogenic spondylodiscitis in the thoracic and lumbar spine, presented with severe back pain, painful dorsal flexion of the spine, radiating pain and fever but with stable spine and without neurological deficits, and had received conservative

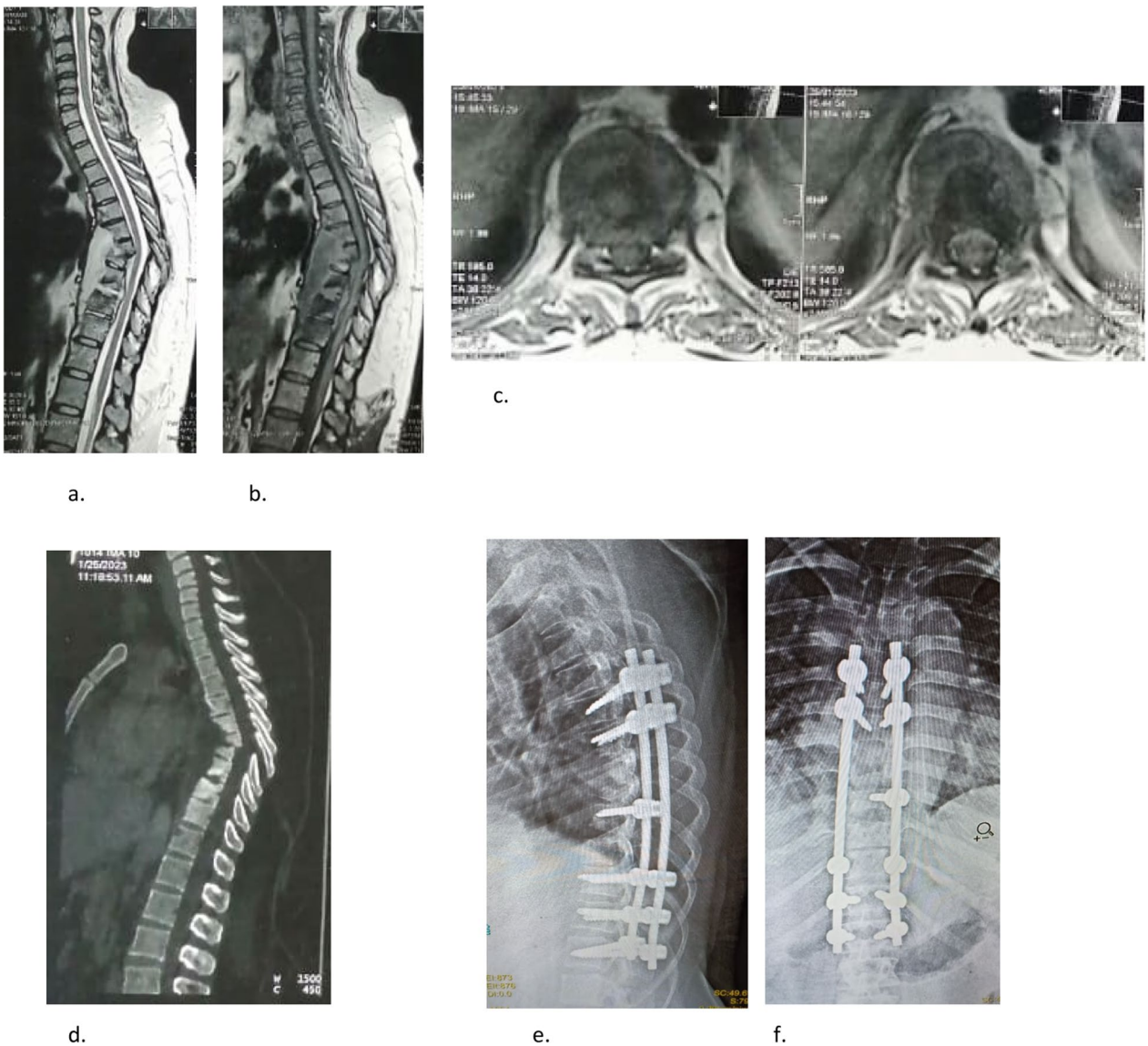

Fig. 2 D7, 8 spondylodiscitis. **a**–**c** preoperative MRI cervicodorsal spine revealed D7-8 spondylodiscitis with kyphosis. **c** Preoperative CT cervicodorsal spine revealed D7-8 spondylodiscitis with kyphosis. **f** Postoperative Plain X Ray dorsal spine revealed long segment posterior fixation with correction of kyphosis with posterior decompression by laminectomy

treatment for three months. They failed to respond to the initial conservative management. Three patients (3/14, 21%) developed neural deficits during conservative therapy demanding immediate decompression and stabilization. five patients (5/14, 36%) had conservative management chance but eventually required posterior decompression and long segment fixation due to severe back pain, persistent or recurrent fever, increasing bone destruction, and high inflammatory markers.

Each patient had rigid long segment posterior transpedicular screw fixation with two levels of fixation above and below the affected disc, except in L5-S1 discs no additional screws were inserted beyond the S1 pedicular screws. Posterior decompression was done in all cases whatever the neurological condition of the patient. In the Lumbar region, debridement of the affected discs was done. In only five cases (36%) did the disc material yield a positive culture. In all cases, formal posterolateral fusion was done utilizing an autogenous bone graft derived from spinous processes and laminae in combination with tobramycin-impregnated calcium sulphate pellets (Osteoset-T; Wright Medical Technology Inc.).

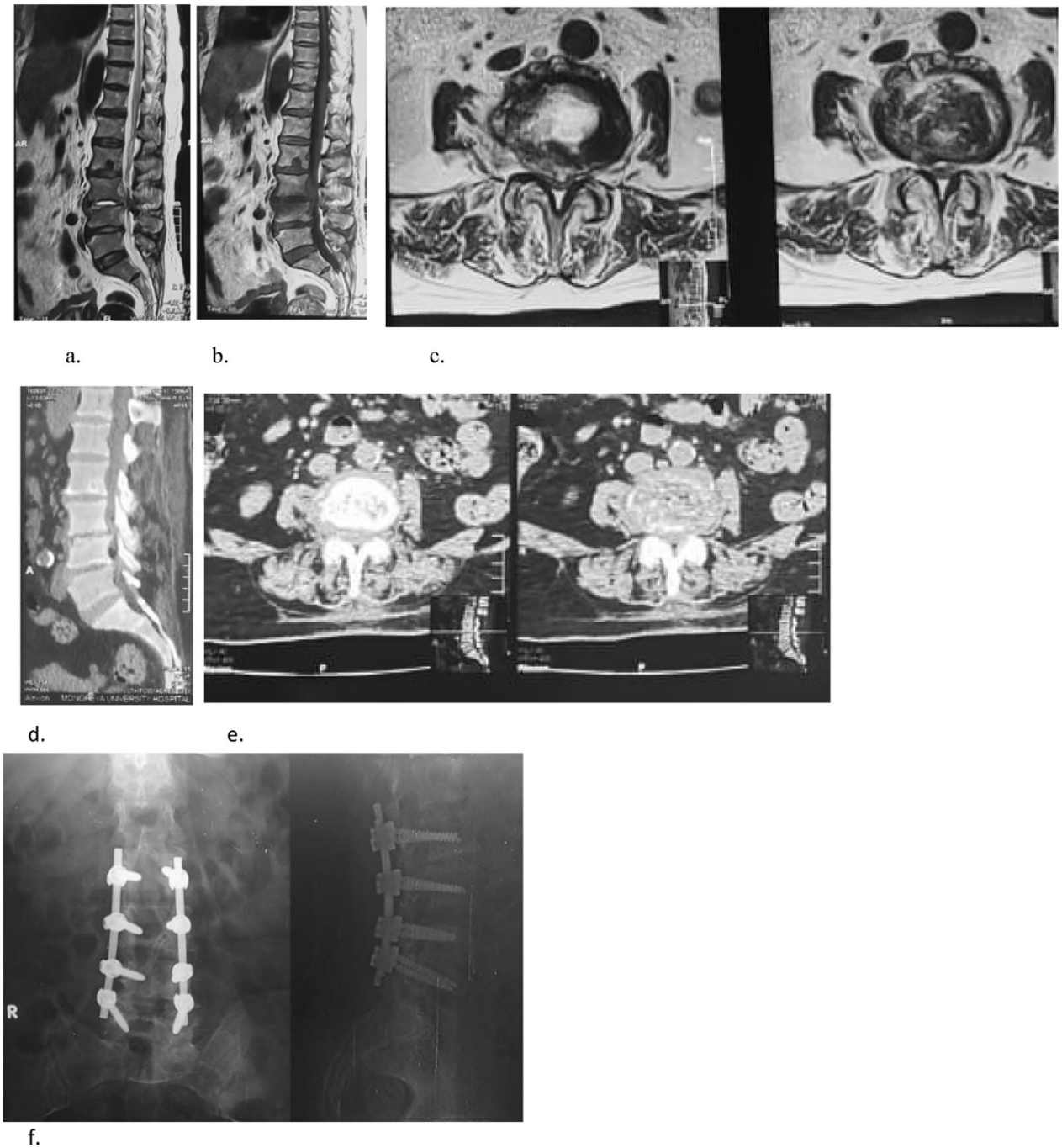

Fig. 3 L3-4 spondylodiscitis. **a**–**c** Preoperative MRI of the lumbar spine showing L3-4 spondylodiscitis. **d**, **e** Preoperative CT of the lumbar spine showing L3-4 spondylodiscitis. **f** Postoperative antero-posterior and lateral radiographs showing L2-3–4-5 posterior trans-pedicular screw fixation with decompression

Patients were allowed to ambulate in a brace on the fourth postoperative day and told to continue wearing the brace for six months. Intravenous antibiotics were given for at least six weeks after surgery, or until the ESR and CRP level returned to normal, followed by six weeks of oral antibiotics.

Plain radiographs; anteroposterior and lateral views, were taken immediately postoperatively then after 2

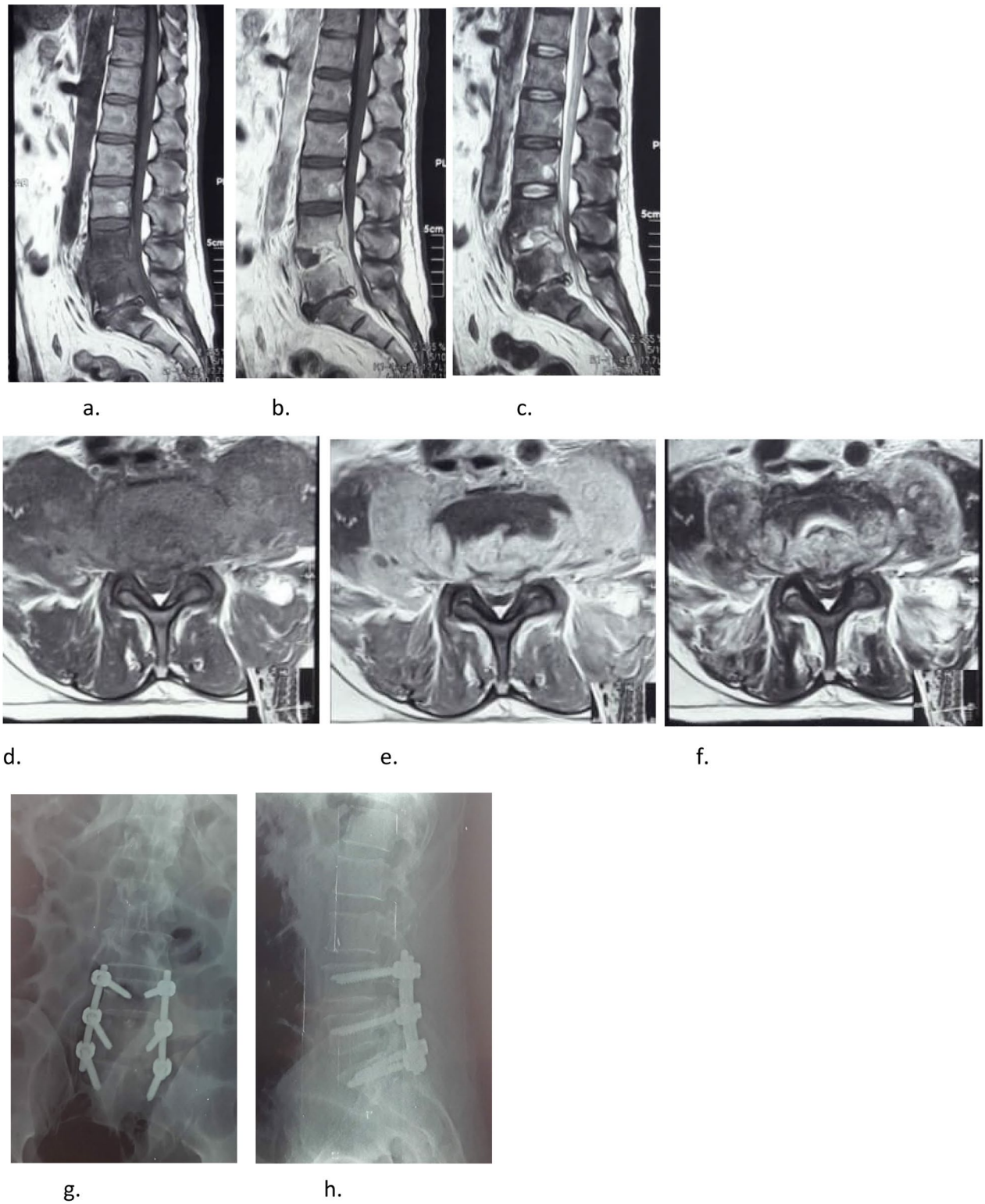

Fig. 4 L4-5-S1 spondylodiscitis. **a**–**f** Preoperative MRI LSS T1, T2, T1 with contrast showed L4-L5-S1 spondylodiscitis. **g**, **h** postoperative MRI LSS; showed L4-L5-S1 fixation by transpedicular screws and posterior decompression by L4-5 laminectomy and debridement

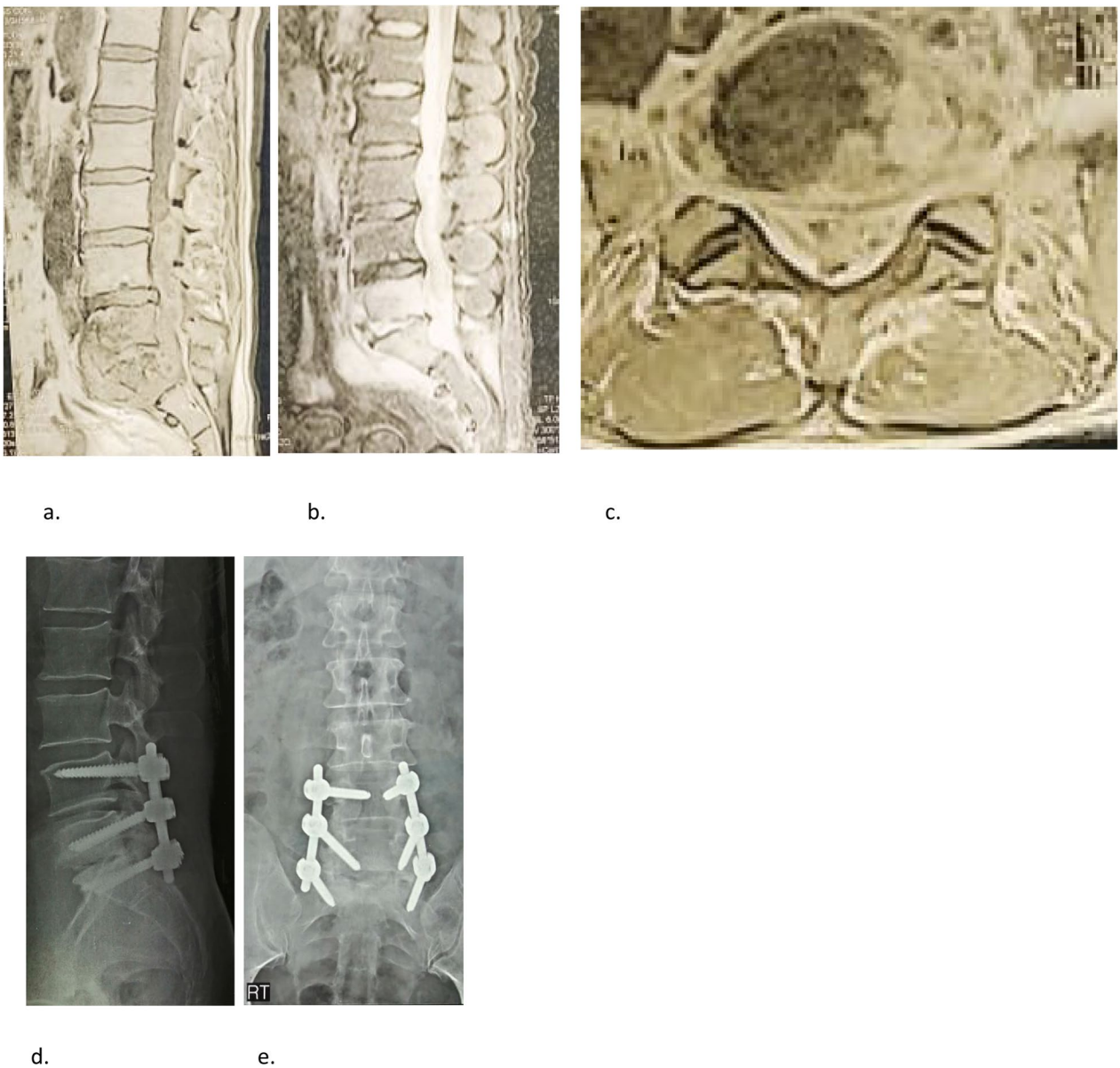

Fig. 5 L5-S1 spondylodiscitis. **a**–**c** Preoperative MRI LSS showed L5-S1 spondylodiscitis. **d**, **e** Postoperative MRI LSS showed L4-5-S1 fixation with transpedicular screws with posterior decompression by L4-5 laminectomy

weeks, three and six month and after one year. Radiographically, solid fusion was defined as the development of bone inside the intervertebral disc space or the presence of a posterior, posterolateral fusion mass (Figs. 1, 2, 3, 4, 5).

The Frankel classification system was used to classify neurological abnormalities;

Grade A: Complete neurological injury—complete loss of motor and sensory function below the injury level.

Grade B: Preserved sensation only—complete loss of motor function below of the injury level; preserved sensory function below the injury level even only partial function (including sacral sparing).

Grade C: Preserved non-functional motor—non useful motor function preserved below the injury level.

Grade D: Preserved motor function-useful motor function preserved below the injury level; patient can walk with or without aid, but does not have a normal gait.

Grade E: Normal motor—normal motor, sensory and sphincteric function [15].

The Kirkaldy-Willis criteria were used to assess functional outcomes;

Excellent: the patient has returned to his normal work and activities.

Good: the patient has returned to his normal work but may have some limitations in other activities and may have back pain, occasionally after heavy work, requiring a rest for few days·

Fair: the patient has reduced his working capacity taking a lighter job or working for part-time.

Poor: the patient does not return to work [16].

Back pain was quantified using the visual analogue scale; the VAS score was determined by asking the case to place the level of discomfort on a horizontal scale from 0 to 10, with 0 indicating no pain and 10 indicating the most severe pain. The score was recorded before and immediately after the procedure, and finally at sixth month follow-up [17].

Statistical analysis

The findings were obtained, sorted, and analyzed using an IBM PC and SPSS version 23 statistical software. (SPSS Inc. Released 2015. IBM SPSS statistics for windows, version 23.0, Armnok, NY: IBM Corp). Descriptive statistics included percentage (%), mean (x) and standard deviation (SD) and analytic statistics included Chi-square test (χ^2), Mann–Whitney test, ANOVA (f) test, Kruskal–Wallis test and Spearman's correlation (r). P value < 0.05 was considered statistically significant.

Results

Fourteen patients with idiopathic active pyogenic spondylodiscitis of the spine in the thoracic and lumbar region were included in this study. Nine patients were males (9/14, 64%), while five cases were females (5/14, 36%). At surgery time, the mean age was 55 years (42–68 yrs.). The affected levels were the thoracic spine in 4 patients (4/14, 28.6%), the lumbar spine in 7 patients (7/14, 50%) and the thoracolumbar junction in 3 patients (3/14, 21.4%). Before surgery, the mean duration of clinical manifestations was 3.2 months (range = 0.5 to 5 months). All patients (14/14, 100%) had constitutional symptoms, severe back pain and painful dorsal flexion of the spine. Radiating pain (Uni- and/or bilateral sciatica) was present in 7 patients (7/14, 50%), while 9 patients (9/14, 60%) had neurological deficits. Six patients (6/14, 43%) presented with acute infection and progressive neurological deficits were subjected for urgent surgical intervention. Eight patients (8/14, 57%) received conservative treatment chance before surgery. The mean duration of the conservative treatment before surgery was 2.2 months (range = 1 to 3 months). The average follow-up period was 12 months (Table 1).

Table 1 Demographic data of patients

Variable	No
Age	Mean = 55 yrs
	Range = 42–68 yrs
Sex	
Females	5 (36%)
Males	9 (64%)
Levels of infection	4 (28.6%)
Thoracic	7 (50%)
Lumbar	
Thoracolumbar	3 (21.4%)
Duration of symptoms before surgery	Mean = 3.2 months
	Range = 0.5 to 5 months
Pre-operative clinical presentations	
Constitutional symptoms	14
Severe back pain	14
Painful dorsal flexion of the spine	14
Uni- and/or bilateral sciatica	7
Neurological deficits	9
The duration of conservative treatment before surgery; 8 cases	Mean = 2.2 months
	Range = 1 to 3 months
Initial surgery; 6 cases	–
The average follow-up period	12 months

At one-year follow-up, all patients had achieved adequate bony fusion without metal work failure. There was no postoperative wound infection, and during follow-up, no patient had infection recurrence at the lesion site. Surgery took an average of 125 min (range 90–180 min). Blood loss was on average 450 mL (range 250–750 mL). Staphylococcus Aureus was cultured in 4 cases and Escherichia Coli was cultured in one case of samples taken during operations.

Before surgery; the mean ESR was 81.7 mm/h (56–110) and the mean CRP level was 39.6 mg/dL (28–62). After surgery, the ESR and CRP levels reduced to normal in 11 patients (79%) within six weeks, and in the remaining three patients within three months.

The main symptom of patients with idiopathic pyogenic spondylodiscitis was severe back pain which was improved significantly after surgery. Prior to surgery, the VAS score for back pain was high (mean 7.6, range 6–9); however, it was decreased markedly after surgery (mean 1.3, range 0–3), ($P < 0.001$).

Nine patients (9/14, 64%) had neurological impairment before surgery. Six patients were fully recovered, while two patients were improved to Frankel D, and one patient improved to Frankel C at final follow-up (Table 2).

The Kirkaldy-Willis criteria determined that 11 individuals had an excellent functional prognosis, two had a good prognosis, and one patient had a fair prognosis (Table 3).

Table 2 The neurological status of the patients by Frankel classification

Preoperative	Total	Final follow-up				
		A	B	C	D	E
A						
B	2			1	1	
C	2				1	1
D	5					5
E	5					5
Total	14			1	2	11

Table 3 The functional outcome according to the Kirkaldy-Willis criteria

Criteria	No	%
Excellent	11	79
Good	2	14
Fair	1	7
poor	–	–
Total	14	100

There was an insignificant relation between both postoperative Frankel classification and the Kirkaldy-Willis criteria and the pre-operative clinical presentations (back pain, sciatica, and the neurological deficits) (Table 4).

Discussion

According to contemporary literature, conservative therapy demonstrates success rates comparable to surgical interventions, albeit with lower complication and mortality rates. When there is no absolute indication for surgery (as neurological impairment, deformity, instability, abscess development, significant bone destruction, intractable severe pain) opting for a conservative approach should be prioritized as the initial treatment strategy [18].

In pyogenic spondylodiscitis, infections and bone destruction affect mainly the anterior vertebral elements resulting in anterior compression of the dura by sequestrated bone and epidural abscess. Therefore, the majority of surgeons use the anterolateral approach to perform debridement of spinal osteomyelitis, anterior decompression and autogenous bone grafting subsequently [19–27].

Since the 1950s, the established surgical procedure for spinal infection has been the comprehensive removal of infected tissue followed by autologous strut bone grafting [10]. In cases involving the thoracic spine, access is typically achieved through thoracotomy or extrapleural approaches, while the lumbar spine is approached retroperitoneally. This approach allows for direct access, facilitating thorough debridement of infected areas and stabilization with bone grafts. However, the anterior approach with fusion has notable drawbacks, including prolonged postoperative bed rest, the necessity for brace usage, challenges in performing the procedure on the lower lumbar spine, potential impairment of lung function in thoracotomy cases, and the risk of graft or body collapse leading to a kyphotic spine. Moreover, major spine surgeries of this nature can pose complications, especially in patients with systemic diseases or compromised immune systems [27].

A few studies have detailed utilizing the posterior approach solely to treat pyogenic spondylodiscitis. In this study, the posterior approach was used but stressed on stabilization as the essential component of therapy. Apart from decompressing the neural components, the affected vertebral level left alone and fixation was done in the levels above and below. There is evidence that bone healing requires the infected location to be

Table 4 Relation between both postoperative Frankel classification and the Kirkaldy-Willis criteria and the pre-operative clinical presentations

	Frankel Classification			*P* value	Kirkaldy-Willis criteria			*P* value
	C	*D*	*E*		Fair	Good	Excellent	
Back pain	1 (100%)	2 (100%)	11 (100%)	–	1 (100%)	2 (100%)	11 (100%)	–
Sciatica	0 (0%)	0 (0%)	7 (63.6%)	0.148	0 (0%)	0 (0%)	7 (63.6%)	0.148
Neurological deficits	1 (100%)	2 (100%)	6 (54.5%)	0.346	1 (100%)	2 (100%)	6 (54.5%)	0.346

completely immobilized. They reasoned that a shorter time to union and improved blood flow associated with early healing would contribute to infection control [8, 21, 22].

In pyogenic spondylodiscitis, infection causes anterior elements bone destruction with lack of anterior support so long segment posterior fixation, at least 2 levels above and 2 levels below the lesion, can provide stronger and firmer posterior fixation, maintain the kyphotic angle correction, especially in relatively osteoporotic spine and reduce of the load exerted upon individual screws preventing subsequent construct failure. Extensive posterior decompression at the infection region, can affect stability however, adjuvant long segment posterior instrumentation could provide firm fixation and maintaining adequate stabilization. After decompression, most patients recovered entirely neurologically and functionally.

The insertion of metal hardware was always a concern in cases of pyogenic infections, but with development of recent transpedicular titanium screws this fear has diminished as studies have shown that titanium has a low tendency for bacterial biofilm creation than on other materials; and this may be aided by administering antibiotics and applying the pedicle screws at the clean areas above and below levels [28–30].

A comprehensive study conducted by Bydon et al. on 118 patients with spinal infection revealed that the rates of repeat surgeries and the persistence of infection were comparable between those who underwent exclusive decompression and those who also received instrumentation [31]. The safety of internal fixation and bone fusion in the presence of infection was also confirmed by other studies [14, 26, 32]. The present study does concur with these findings, as complete control of the infection and bone fusion were achieved despite using instrumentation in pyogenic spondylodiscitis in all patients.

In this study, no extensive debridement was performed and despite this infection control and fusion were achieved and these results are in concordance with Tschöke et al., where they recorded effective resolution of infection through moderate debridement, that involves linking separated deep purulent cavities to the surface while concurrently applying the suitable antimicrobial therapy postoperatively [33].

Martin et al. stressed upon the importance of recognition of progressive preoperative neurological deficit (essentially motor) and these patients should be offered rapid medical-surgical action, in their series 44.6% of their patients presented with some type of deficit [34]. Similarly, in the present study, 60% had deficit and 43% of all patients showed rapid progression necessitating early surgical intervention.

Martin et al. reported that 96.4% of their patients improved or remained stable, and despite being faced by frequent surgical complications (42%) they rarely caused severe morbidity [34]. In the present study, we had a comparable patients improvement rate with no surgical complications or mortalities, which may be attributed to the smaller number of patients included or because only the posterior approach was used with no anterior approaches or thoracotomies were performed in this study.

Stabilization of the infected spine through posterior long segment pedicle screw fixation and bone fusion not only enables early patient movement minimizing the risk of long-term bed rest complications but it also offers potential relief from back pain due to the firm fixation. In this series, the patients were advised by the early mobilization and marked reduction of back pain, with improvement of the VAS score from an average of 7.6 preoperatively to 1.3 after surgery ($P<0.001$). This correlates with Lin et al., Mohamed et al., Mauro Dobran et al., Aljawadi et al. and Mohamed et al. who reported that in idiopathic pyogenic spondylodiscitis of the thoracic and Lumbar spine, the posterior pedicle screws fixation with posterior decompression only without formal debridement and combined with proper antibiotics administration, provides firm stabilization, maintaining kyphotic angle correction, neurological function recovery and marked back pain relief. None of these patients presented with relapse of spinal infection during follow-up [35–39].

Conclusions

The posterior long-segment fixation combined with decompression of the infected area only without extensive debridement and combined with proper antibiotics administration, was effective and safe in the in surgical management of idiopathic active pyogenic spondylodiscitis of the spine in the thoracic and lumbar region, with the majority of patients achieving early ambulation and a good functional outcome following surgery.

Abbreviations

ESR	The erythrocytic sedimentation rate
CRP	C-reactive protein
WBC	White blood cell count
X ray	Plain radiographs
MRI	Magnetic resonance imaging
ALIF	Anterior lumbar interbody fusion
PLF	Posterolateral fusion
PLIF	Posterior interbody fusion
XLIF	Extreme lateral interbody fusion
VAS	Visual analogue scale

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Author contributions

Both authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis

and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Availability of data materials
All data and materials included in this work are available.

Declarations

Ethics approval and consent to participate
Following a succinct and clear explanation of the study's objectives, all participants gave signed informed permission. The consent form was designed in accordance with the Helsinki Declaration and the standards of the Egyptian Ministry of Health's Quality and Improvement System. The study plan was approved by the local ethical scientific committee of the Menoufia Faculty of Medicine, Menoufia, Egypt (ID: 5/2022NEUS7).

Consent for publication
Not applicable.

Competing interest
The authors declare no competing interests in this work.

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