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REVIEW

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One-stage posterior debridement approach combined with autogenous bone grafting and internal fixation for the treatment of adult thoracic or lumbar suppurative spondylitis via the multifidus and longissimus interspaces

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Abstract

Background Surgical treatment of suppurative spondylitis requires focus debridement, spinal stability, and deformity correction. Different approaches face challenges like complex anatomical structures and greater trauma. The aim is to evaluate the clinical efficacy of One-stage debridement approach combined with autogenous bone grafting and internal fixation for the treatment of adult thoracic or lumbar suppurative spondylitis via the multifidus and longissimus interspaces.

Methods From July 2018 to July 2021, 91 patients (65 male, 26 female) with single - level thoracic or lumbar suppurative spondylitis underwent the one-stage posterior procedure. Operative details and hospital stay were recorded. ESR, CRP, and PCT levels were analyzed at specific times. Pain was rated by VAS, Using ODI score to evaluate the improvement of lumbar activity, and neurological function was assessed by ASIA scale. Cobb angles were measured for deformity evaluation. Bony fusion was evaluated by radiography and computed tomography.

Results The mean operative duration was 195.6 ± 15.4 min, blood loss was 575.9 ± 90.1 ml, and hospital stay was 19.9 ± 2.2 days. ESR, CRP, and PCT levels significantly decreased before discharge (ESR: 80.2 ± 14.6 mm/h vs. 30.2 ± 8.9 mm/h, CRP: 58.5 ± 13.6 mg/L vs. 15.1 ± 7.4 mg/L, PCT: 0.8 ± 0.2 ng/ml vs. 0.1 ± 0.1 ng/ml, $P < 0.05$). All patients had pain relief. VAS scores improved (preoperative 7.7 ± 1.1, before discharge 2.8 ± 0.6, final follow-up 1.3 ± 0.6). The lumbar activity of all patients was significantly improved compared with preoperative(preoperative 41.36 ± 3.20, final follow-up 6.18 ± 1.33). Neurologically impaired patients improved in ASIA grade. The mean preoperative Cobb angle was 19.6 ± 1.6°, reduced to 6.2 ± 1.5° before discharge and 9.4 ± 1.0° at final follow-up. The mean angle correction was 13.4 ± 0.6°, correction rate 68.7% ± 5.4% ($P < 0.05$), with a final loss angle of 3.2 ± 0.7° and loss rate 24.1% ± 4.8%. All grafts achieved complete fusion.

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Conclusions This one-stage posterior approach is effective and feasible for adult single - level thoracic or lumbar suppurative spondylitis, protecting paravertebral muscles and posterior ligament complexes. However, further studies with larger samples and longer follow-up are needed.

Keywords Posterior approach, Thoracic and lumbar, Suppurative spondylitis, Multifidus and longissimus interspaces, Bone grafting, Debridement, Internal fixation

Introduction

Septic spondylitis is a nonspecific infection, also known as spinal suppurative osteomyelitis, which often involves the vertebral bodies, intervertebral discs, and the surrounding soft tissue. *Staphylococcus aureus* and *Escherichia coli* are the primary infective agents [1], accounting for 1% of systemic infections and 2–7% of osteomyelitis cases [2, 3]. The lumbar vertebrae are the most common sites of infection, followed by the thoracic vertebrae, whereas infection of the cervical and sacral vertebrae is rare [4]. Suppurative spondylitis is more common among middle-age and elderly individuals in poor physical condition and low immunological resistance. Its onset is slow and insidious, and clinical manifestations and accessory examinations lack specificity. Because early diagnosis is difficult, it can easily lead to misdiagnosis and missed diagnosis and is eventually complicated by kyphosis and neurological deficits, which seriously affect the quality of life of those affected [5].

Treatment strategies for thoracic and lumbar suppurative spondylitis include conservative and surgical approaches. Conservative treatment is the primary strategy for thoracic and lumbar suppurative spondylitis. Most patients can achieve curative effects through conservative treatment; however, for those with neurological impairment and destruction of spinal stability, conservative treatment is ineffective, and surgical treatment is required [6]. Surgical objectives include lesion removal, spinal canal decompression, deformity correction, bone graft fusion, and internal fixation. Currently, the surgical treatment of thoracic and lumbar suppurative spondylitis is controversial [7, 8], including surgical indications, surgical methods, internal fixation, and bone graft fusion materials. Surgical methods, including anterior, posterior, and combined anterior-posterior approaches, have advantages and disadvantages. Anterior surgery can achieve complete debridement under direct visualization without destroying the structure of the posterior column. The approach has always been considered the gold standard for the treatment of infectious diseases of the thoracic and lumbar spine [9, 10]. However, the anterior approach has many disadvantages, such as complex anatomical structures, greater trauma, more blood loss, insufficient internal fixation strength, more complications, and a long learning curve [11, 12]. The combination anteroposterior approach can completely remove the lesion and achieve firm fixation; however, changing patient position during surgery leads to prolonged operative duration, increased trauma, and possible complications of the anterior approach. In recent years, some physicians have treated lumbar suppurative spondylitis using a one-stage posterior median approach for debridement, bone graft fusion, and internal fixation, and have achieved favorable results [13–16]. However, the traditional posterior median approach requires extensive dissection and traction of the paraspinal muscles, causing avascular necrosis, muscle atrophy, and denervation of the paraspinal muscles, ultimately resulting in complications, such as flat back syndrome and intractable low back pain [17–21].

With advances in minimally invasive concepts and techniques, the transmuscular (i.e., Wiltse) approach has been widely used in the surgical treatment of thoracolumbar fractures and degenerative diseases [22–25], which can effectively reduce muscle stripping and bleeding, and greatly reduce postoperative intractable low back pain and other complications. However, the application of this technique in thoracic and lumbar suppurative spondylitis has rarely been reported. As such, the present study investigated the clinical efficacy of a one-stage posterior approach via the multifidus and longissimus interstitial interspaces for the treatment of single - level thoracic or lumbar suppurative spondylitis with debridement, bone grafting, and internal fixation.

Materials and methods

General materials

Data from 91 patients were diagnosed with single - level thoracic or lumbar suppurative spondylitis, who underwent surgical treatment at the author's hospital between July 2018 and July 2021, were included in this study. The study protocol was approved by the ethics committee of the author's hospital. All surgeries were performed in the department by the same experienced surgeon. Patients with ≥ 2 of the following criteria were included: progressive local deformity (kyphosis and/or scoliosis); neurological impairment; persistent pain due to spinal instability; and poor outcomes following conservative treatment. Individuals who did not undergo surgery, those who underwent combined anterior and posterior or non-muscular space posterior surgery, those with recurrence of suppurative spondylitis, and infection after spinal surgery were excluded(Fig. 1). Suppurative spondylitis was diagnosed based on clinical symptoms, imaging

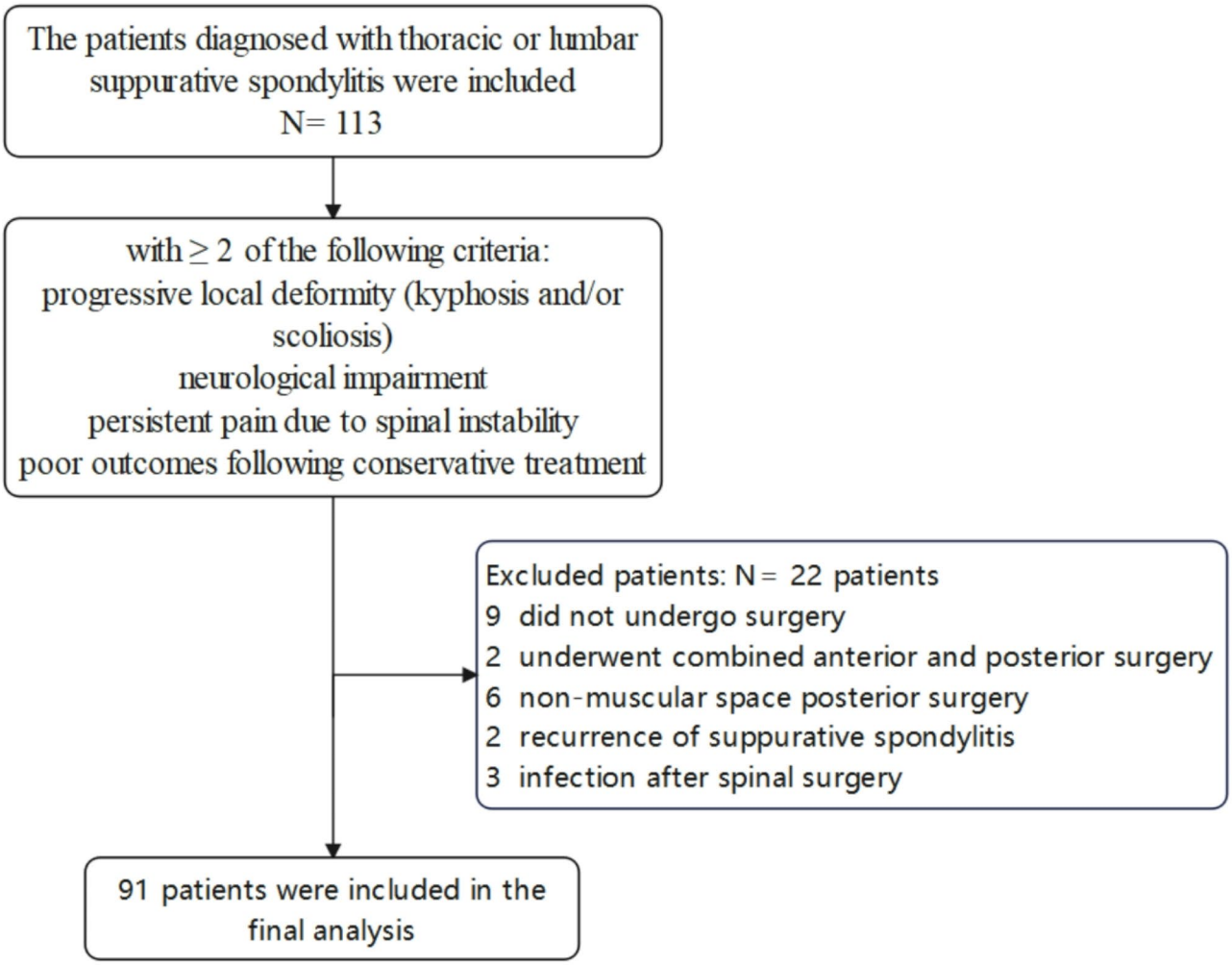

Fig. 1 Flow chart of the included patients

results, including radiography, computed tomography (CT), magnetic resonance imaging (MRI), and laboratory investigations, such as procalcitonin (PCT), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). Suppurative spondylitis was confirmed on pathological examination.

Surgical methods

After induction of general anesthesia, patients were positioned prone with somatosensory-evoked potential monitoring. Using the Wiltse technique [26], a long midline incision of the appropriate length was made at the surgical level, and the subcutaneous tissue and muscle space between the longissimus and multifidus were then bluntly separated to expose the entry point for each pedicle (trapezius, rhomboid, latissimus dorsi needed to be bluntly separated in the thoracic spine). The diseased vertebrae were identified using C-arm fluoroscopy. Pedicular screws were placed in the vertebrae in accordance with preoperative planning. After placing the screws, a temporary rod was placed on the contralateral side and appropriately stretched. Excision of the transverse process exposed the damaged intervertebral space. Abscesses in the spinal canal, articular process, and lamina could then be partially excised. Diseased vertebrae were located in the thoracic spine, transverse process, and parts of the ribs, and the costovertebral joints were cut off for easy manipulation. Collapsed vertebrae, necrotic disc tissue, and epidural or paravertebral abscesses were completely debrided. If the bilateral vertebrae were severely damaged, the rod was exchanged on the other side, and the same debridement and decompression procedures were repeated. Debrided tissues were sent for bacterial culture and pathological examination. Autogenous bone harvested from the rib and transverse process (in the thoracic spine), lamina, or tricortical iliac crest using ultrasonic osteotome (in the lumbar spine, SMTP XD860A) filled the intervertebral space for structural strut grafting. The articular process of the diseased vertebrae is a fusion. Finally, the two rods

were fixed, and both sides were compressed to correct the local deformity. Two drainage tubes were inserted before the incision was sutured. Representative cases are shown in Figs. 2 and 3.

Postoperative management

After surgery, intravenous infusion of antibiotics was routinely administered for 3–4 weeks according to bacterial culture results and then changed to oral administration for 3–4 weeks. For inpatients with negative bacterial cultures, broad-spectrum antibiotics were used to treat the most common pathogens (*S. aureus* and *E. coli*). For infections caused by S. aureus, common antibiotic regimens include intravenous cefuroxime for 3–4 weeks, followed by oral cefuroxime for 3–4 weeks. In the case of E. coli infections, intravenous ceftriaxone for 3–4 weeks, and then oral levofloxacin for 3–4 weeks are often used. These regimens are selected based on the sensitivity of the bacteria and the patient's condition. All patients underwent continuous closed washing and drainage for 10–14 days after surgery, and the drainage tube was removed when the drainage volume was < 30 ml per 24 h. During bed rest, active and passive functional exercises of the lower limbs were implemented to prevent

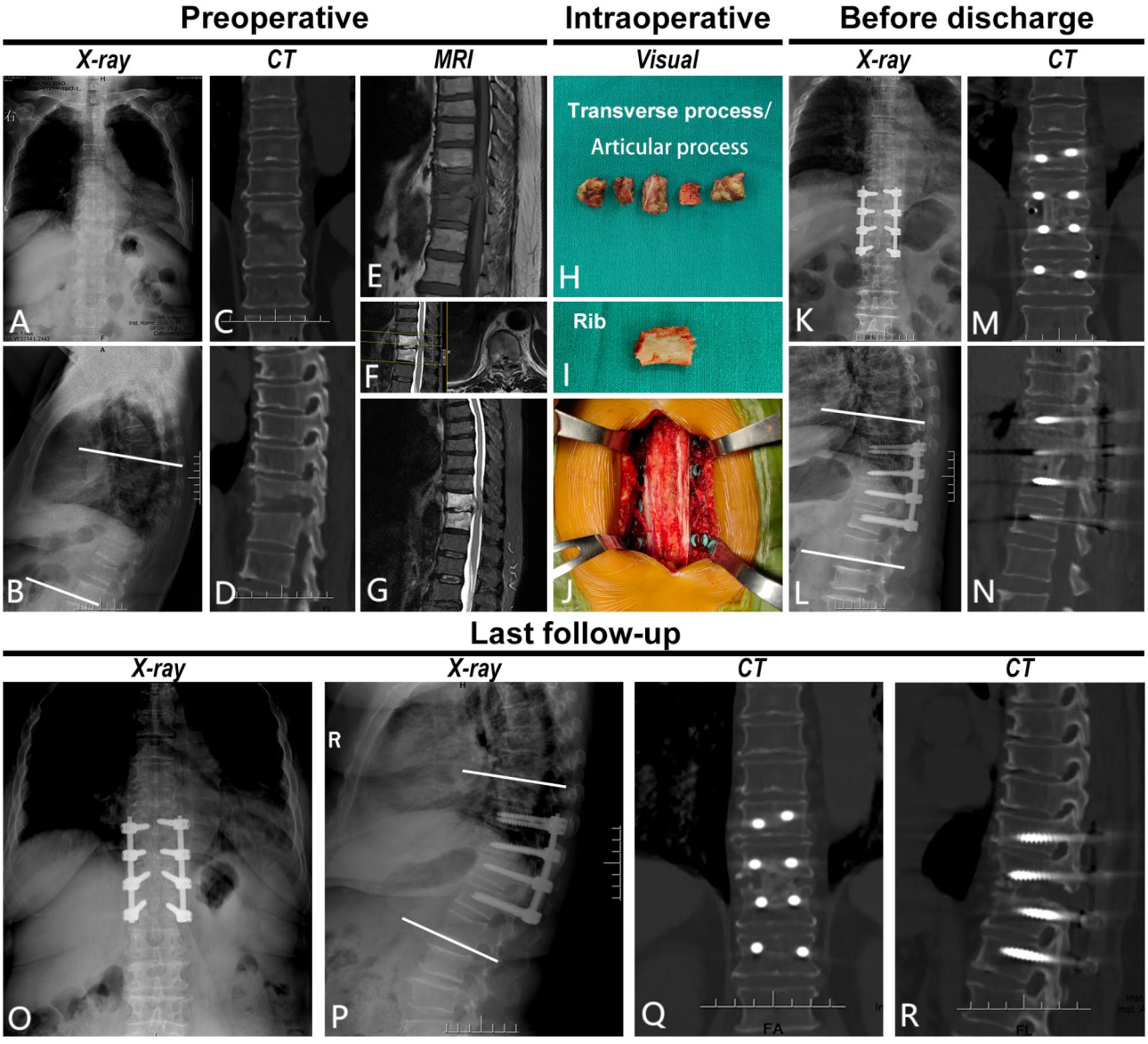

Fig. 2 A 70-year-old female was diagnosed with thoracic suppurative spondylitis and incomplete paralysis. Neurological deficit was ASIA D. **A**-**B** preoperative X-ray showed that T_7-T_8 vertebral body destroyed. **C**-**G** preoperative CT and MRI showed T_7-T_8 vertebral body destruction with spinal canal abscess and spinal cord compression. **H**-**J** intraoperative image showed one-stage posterior debridement, autogenous bone grafting, and internal fixation via the multifidus and longissimus interspaces. **K**-**N** postoperative X-ray and CT before discharge showed well-positioned struting bone grafting and instrumentation. **O**-**R** X-ray and CT presented a favorable alignment and satisfactory bone fusion at 13-month follow-up

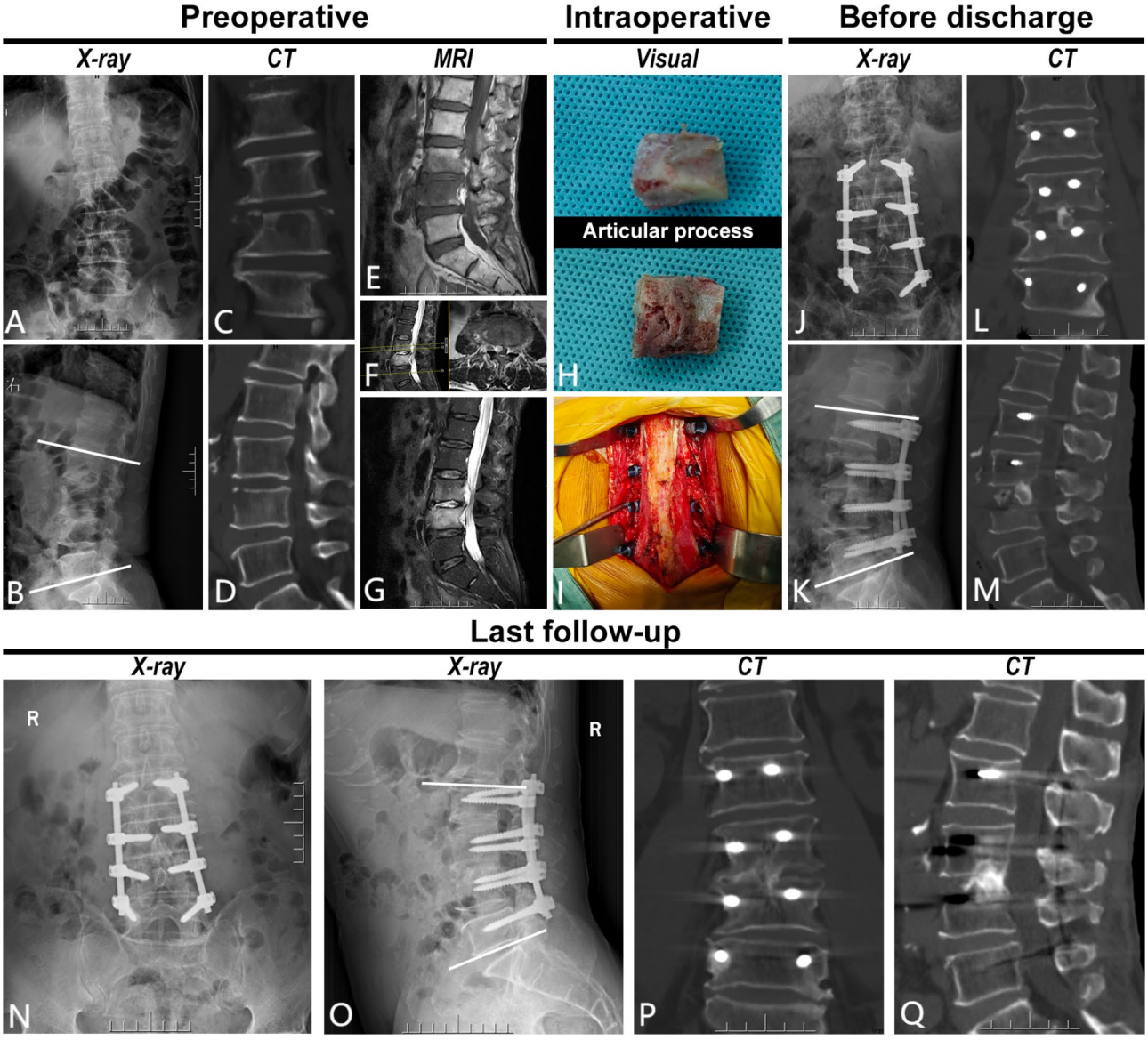

Fig. 3 A 58 years old male with L_3/L_4 suppurative spondylitis after a 2 months history of intermittent back pain and numbness in both lower limbs. **A**-**D** preoperative X-ray, CT showed L_3/L_4 vertebral body and endplate destruction. **E**-**G** preoperative MRI showed diffuse abnormal signals of L_3/L_4 vertebra and intervertebral disc, abscess of lumbar major muscle. **H**, **I** intraoperative image showed internal fixation through multifidus and longissimus interspaces and articular process strutting bone grafting. **J**-**M** X-ray and CT showed position of internal fixation and bone graft were good, before discharge. **N**-**Q** X-ray and CT indicated satisfactory fusion of bone graft and good location of internal fixation at 18 months post-operation

deep venous thrombosis. Anemia and hypoproteinemia improved over time. After removing the drainage tube, the patients were permitted to ambulate with the effective support of a thoracolumbosacral orthosis (TLSO) brace for 3–6 months. The TLSO brace is designed to provide support and stability to the thoracic and lumbar spine, helping patients maintain proper posture and reducing stress on the surgical site during the recovery process.

Follow-up evaluation and complications

ESR, and CRP and PCT levels were recorded to monitor infection preoperatively and before discharge. A visual analog scale (VAS) was used to evaluate pain severity and the American Spinal Injury Association (ASIA) impairment scale was used to evaluate neurological impairment preoperatively, before discharge, and at the final follow-up. The Oswestry Disability Index (ODI) impairment scale was adopted to evaluate the lumbar function status before surgery and at the last follow - up. The degree of local deformity (Cobb angle) was recorded on lateral radiographs preoperatively, before discharge, and at the

Table 1 Characteristics and clinical data of the patients

Variable	Statistic
Mean age/years	57.0 ± 11.3
Gender	
Male	65
Female	26
Region of tuberculosis	
Thoracic (T1-10)	17
Thoracolumbar(T11-L2)	42
Lumbar (L3-L5)	34
Mean surgery duration (minutes)	195.6 ± 15.4
Mean blood loss (ml)	575.9 ± 90.1
Average hospital stays(days)	19.9 ± 2.2
Average follow-up period(months)	24.1 ± 4.0
Bone graft type	
Three cortical iliac bone grafts	33
Ribs and transverse process bone grafts	20
Lamina bone grafts	38

final follow-up to evaluate local deformity correction and loss of correction. Radiography and CT images were used to evaluate bony fusion according to the classification described by Siepe et al. [27], including clearly visible continuous trabecular bone growth connecting the vertebral bodies, with evidence of bony remodeling of the callus. Intraoperative complications were recorded, and postoperative complications were evaluated according to clinical findings and radiographs of each patient.

Statistical analysis

Normally distributed measurement data are expressed as mean and standard deviation (SD), non-normally distributed data are expressed as median and quartiles, and enumeration data are expressed as number and percentage. Before-and-after comparison of the measurement data satisfying the normal distribution within the group was performed using a paired *t*-test, and the paired rank-sum test was used for measurement data that did not exhibit a normal distribution. Normality tests were performed using the Shapiro–Wilk test. All hypothesis tests were considered to be statistically significant at $P < 0.05$. Statistical analyses were performed using SPSS version 25.0 (IBM Corporation, Armonk, NY, USA) for Windows (Microsoft Corporation, Redmond, WA, USA).

Results

Data from 91 patients (65 male, 26 female) who fulfilled the inclusion criteria were reviewed retrospectively. The mean (± SD) age of the patients was 57.2 ± 11.3 (range 31–79 years) at the time of surgery, and the mean follow-up period was 24.1 ± 4.0 months. The mean operative duration was 195.6 ± 15.4 min, mean blood loss during surgery was 575.9 ± 90.1 ml, and mean length of hospital stay was 19.9 ± 2.2 days. The suppurative spondylitis regions included 17 thoracic (T1–T10) and 76 thoracolumbar/lumbar (T11–L5) regions (Table 1). Three cortical iliac bone grafts were used in 33 patients, rib and transverse process bone grafts in 20, and lamina bone grafts in 38.

All patients experienced obvious pain relief. The mean preoperative VAS score was 7.7 ± 1.1, which dramatically decreased to 2.8 ± 0.6 before discharge ($P < 0.05$), and further decreased to 1.3 ± 0.6 at the final follow-up ($P < 0.05$) (Table 2). The mean preoperative values for ESR, CRP and PCT were 80.2 ± 14.6 mm/h, 58.5 ± 13.6 mg/L, 0.8 ± 0.2 ng/ml, and declined to 30.2 ± 8.9 mm/h, 15.1 ± 7.4 mg/L, 0.1 ± 0.1 ng/ml, respectively, before discharge. ESR, and CRP and PCT levels were significantly decreased following surgical treatment ($P < 0.05$).

Data regarding ASIA impairment scale scores are summarized in Table 2. Of the 10 patients with neurological impairment, 9 returned to normal at the final follow-up, while 1 did not due to severe spinal cord compression. The lumbar function of the patients improved significantly after surgery. The ODI score at the last follow-up was significantly better than that before surgery, and the difference was statistically significant ($P < 0.05$). There was no significant difference between genders ($P > 0.05$). (Table 3).

Suppurative spondylitis was confirmed in all patients based on pathological diagnosis and/or bacterial culture. Postoperative bacterial cultures were positive in

Table 2 Characteristics and clinical data of the patients

Time	VAS	ESR (mm/h)	CRP (mg/L)	PCT (ng/ml)	ASIA		
					C	D	E
Preoperative	7.7 ± 1.1	58.5 ± 13.6	58.5 ± 13.5	0.8 ± 0.2	1	9	81
Before discharge	2.8 ± 0.6[a]	30.2 ± 8.9[a]	15.1 ± 7.4[a]	0.1 ± 0.1[a]	0	6	85
At final follow-up	1.3 ± 0.6[b]	-	-	-	-	1	90
t value	38.439/ 50.588	27.905	26.817	38.329	-	-	
P value	< 0.001	< 0.001	< 0.001	< 0.001	-	-	

Abbreviations: VAS, Visual Analogue Scale; ESR, Erythrocyte Sedimentation Rate; CRP, C-Reactive Protein; PCT, Procalcitonin; ASIA, American Spinal Injury Association

[a] $P < 0.05$ vs. preoperative

[b] $P < 0.05$ vs. preoperative

Table 3 ODI score preoperative and at the final follow-up

Gender	*N*	Preoperative	Final follow-up	*P*
Male	65	42.12 ± 3.42	5.92 ± 1.95	*P* < 0.05
Female	26	40.85 ± 3.32	6.29 ± 1.35	*P* < 0.05
Overall	91	41.36 ± 3.20	6.18 ± 1.33	*P* < 0.05
		P > 0.05	*P* > 0.05	

Abbreviations: ODI, The Oswestry Disability Index

Table 4 Bacterial culture result of the patients

Result	Positive (*N* = 74)		Negative (*N* = 17)
Kinds	Staphylococcus aureus	33	--
	Escherichia coli	24	
	Staphylococcus epidermidis	11	
	Brucella	3	
	Methicillin-resistant Staphylococcus aureus(MRSA)	2	
	Candida tropicalis	1	

Table 5 Cobb angle, angle correction and angle lost

Characteristics	Descriptive statistics
Preoperative Cobb angle (°)	19.6 ± 1.6
Cobb angle before discharge (°)	6.2 ± 1.5
Angle correction (°)	13.4 ± 0.6°
Correction rate (%)	68.7 ± 5.4
Cobb angle at final follow-up (°)	9.4 ± 1.0°
Angle lost (°)	3.2 ± 0.7°
Lost rate (%)	24.1 ± 4.8
t/p	57.825/<0.001[a] 50.278/<0.001[b]

[a] *P* < 0.05 vs. before discharge

[b] *P* < 0.05 vs. final follow-up

Table 6 Complications

Complication	*N*	Incidence (%)
Pleural effusion	2	2.2
Segmental vascular injury	1	1.1
Delirium syndrome	3	3.3
Lower extremity numbness	2	2.2

74 patients, including: *S. aureus* (*n* = 33); *E. coli* (*n* = 24); *Staphylococcus epidermidis* (*n* = 11); Brucella (*n* = 3); methicillin-resistant *S. aureus* (MRSA [*n* = 2]); and *Candida tropicalis* (*n* = 1). Bacterial cultures were negative in 17 patients (Table 4). The mean preoperative Cobb angle was 19.6 ± 1.6°, which decreased to 6.2 ± 1.5° before discharge. The mean angle correction was 13.4 ± 0.6°, and the correction rate was 68.7%±5.4%. At the final follow-up, the mean Cobb angle was 9.4 ± 1.0°. The mean angle loss and angle loss rate were 3.2 ± 0.7°, 24.1%±4.8%, respectively (Table 5). Radiography and CT were performed as routine examinations to evaluate bone fusion. All patients achieved thorough intervertebral bone fusion at the final follow-up.

Complications relevant to surgery are summarized in Table 6. One patient experienced a segmental vascular injury that was cured with interventional therapy. Three patient developed delirium syndrome postoperatively, which gradually disappeared with the oral administration of olanzapine. Two patients with pleural effusion were cured using closed thoracic drainage, anti-infection therapy, and lung function exercises. Two patients with lumbar suppurative spondylitis experienced different degrees of postoperative lower-extremity numbness and recovered with conservative treatment. There was no loosening, breakage in internal fixation, or graft-related complications, such as absorption and collapse. The postoperative complications were mainly related to the basic physical condition, infection site and infection severity of the patients. There was no significant relationship between each complication and the type of bone graft.

Discussion

Features of thoracic and lumbar suppurative spondylitis

Suppurative spondylitis, also known as spinal suppurative osteomyelitis, is a non-specific infection that accounts for approximately 1% of all skeletal system infection and 2–7% of osteomyelitis cases [2, 3]. It can be divided into vertebral osteomyelitis, discitis, and epidural abscess, depending on the site [1, 28, 29]. The lumbar spine is the most common, followed by the thoracic vertebrae, while the cervical and sacral vertebrae are rare sites [4]. Suppurative spondylitis usually originates from blood-borne infections, mainly *S. aureus* and *E. coli* [1], and is often secondary to other body infections, such as skin, respiratory system, urinary tract, gastrointestinal tract, and endocarditis [30]. In this study, *S. aureus* and *E. coli* were found in 63% of cases. Due to the use of antibiotics before surgery and the development of drug resistance, bacterial cultures did not detect bacteria in some cases (18.7% [17/91]), and pathological examination confirmed suppurative spondylitis (Table 4). Most patients have a history of underlying diseases, such as diabetes, coronary heart disease, or immunosuppressive disease(s) [31]. In the present study, 37 patients had accompanying diseases. The second is a non-blood infection, which is mostly caused by local infection. In this study, 13 cases had a history of invasive interventions before surgery (e.g., acupuncture, acupotomology).

Suppurative spondylitis often occurs in patients with weak physical condition(s) and low immunological resistance in the elderly. Clinical manifestations lack specificity, early symptoms are relatively concealed, and some patients have no accompanying fever. There is a specific incubation period before onset and, in the later stages, severe chest, waist, and back pain often occurs [5, 32]. Early diagnosis is difficult; the rate of misdiagnosis and missed diagnosis is high, and patients are prone to

neurological impairment, spinal deformities, and even death. Radiography revealed intervertebral stenosis and limited bone destruction near the endplate. Magnetic resonance imaging (MRI) revealed extensive invasive changes in the intervertebral space and adjacent vertebrae, and paravertebral or intraspinal abscesses. MRI is the gold standard for diagnosing suppurative spondylitis with an accuracy and sensitivity of up to 90% [33–35] and is the currently preferred imaging method.

Features of this surgical method

The surgical objectives of thoracic and lumbar suppurative spondylitis include debridement, spinal decompression, deformity correction, bone graft fusion, and internal fixation. Surgical methods include simple debridement, debridement with bone graft fusion, debridement with bone graft fusion, and internal fixation, which can be completed using the anterior, posterior, and combined anterior-posterior approaches. The optimal surgical approach for treating thoracic and lumbar suppurative spondylitis remains controversial. Each surgical approach has advantages and disadvantages, and different approaches should be selected according to the lesion site, degree of destruction, kyphosis, and technical proficiency of the surgeon.

Some investigators have reported that the treatment of lumbar suppurative spondylitis using a one-stage posterior median approach with debridement, bone graft fusion, and internal fixation achieved outstanding results [13–16]. However, the traditional posterior midline approach requires extensive dissection and stretching of the paraspinal muscles, resulting in avascular necrosis, muscle atrophy, and denervation of the paraspinal muscles, leading to complications, such as flat back syndrome and intractable low back pain [17–21].

In 1968, Wiltse et al. [26] described a surgical approach for lumbar spondylolisthesis involving pedicle screw insertion and posterolateral fusion via the multifidus and longissimus interspaces. Since then, it has been gradually used in the treatment of thoracolumbar fractures and degenerative diseases [22–25]. We have innovatively applied this technology for the treatment of thoracic and lumbar suppurative spondylitis, which has advantages. First, compared with the traditional posterior median surgical approach, this surgical approach only exposes the pedicle entry point without stripping the paravertebral muscles and exposing the articular process, which protects the blood supply and innervation of the posterior muscle group and prevents paraspinal muscle denervation atrophy. Consequently, integrity of the posterior ligament complex was maintained. Suturing the thoracolumbar fascia can form a complete barrier to prevent the anterior lesion spreading to the posterior normal structure. Second, pedicle screws are placed at an ideal angle to achieve greater power and are less prone to internal fixation loosening and breaking. Third, the transverse process and costovertebral joints can be excised to enlarge the surgical field, and focus debridement can be accomplished posteriorly and anterolaterally, avoiding excision of the lamina, articular process, and spinous process and preserving the integrity of the posterior bony structure, thus reducing the risk for dural injury and increasing spinal stability. Compared with the anterior approach or combined anterior-posterior approach, it can avoid surgical complications, shorten operative duration, and reduce surgical trauma. Fourth, compared with the anterior approach, this approach can still achieve structural strut grafting through the lateral side to reconstruct the anterior and middle column pressure belts and combine pedicle screw technology to provide a stable mechanical environment for bony fusion and effectively correct local kyphosis. In this study, the mean kyphotic angle before discharge ($6.2 \pm 1.5°$), which was significantly improved compared with preoperative ($19.6 \pm 1.6°$ [$P < 0.05$]), and the corrected loss angle had a degree of $3.2 \pm 0.7°$ loss at the last follow-up, without statistical difference. Fifth, patients with a psoas abscess that can be removed by longitudinal incision of the anterior layer of the thoracolumbar fascia.

Compared with the anterior approach, our one - stage posterior approach via the multifidus and longissimus interspaces has distinct advantages. The anterior approach can achieve direct visualization for debridement without disrupting the posterior column structure. However, it has complex anatomical structures, leading to greater trauma and more blood loss [11]. In our study, the mean blood loss in our posterior approach was 575.9 ± 90.1 ml, while the anterior approach usually has higher blood loss. Also, the internal fixation strength of the anterior approach is insufficient, and it has a long learning curve [12]. Our posterior approach can place pedicle screws at an ideal angle, reducing the risk of internal fixation loosening and breaking. Moreover, the anterior approach may require more complex procedures for bone grafting and internal fixation. In contrast, our approach can still achieve structural strut grafting through the lateral side to reconstruct the anterior and middle column pressure belts and combine pedicle screw technology to provide a stable mechanical environment for bony fusion. Although the anterior approach can directly access the anterior part of the spine, our posterior approach can avoid many of its drawbacks, such as reducing the risk of dural injury by preserving the integrity of the posterior bony structure. Additionally, the anterior approach may have a higher risk of complications related to the surrounding tissues, while our approach can suture the thoracolumbar fascia to form a

barrier, preventing the spread of the anterior lesion to the posterior normal structure.

According to our experience, several precautions should be exercised during the operation. First, if the infection lesion is located in the lumbar spine, because the operating field is relatively small, the intervertebral space can be moderately strutted before implanting the bone graft by the contralateral pedicle screw. More attention should be devoted to nerve roots to avoid postoperative complications related to nerve root injury. In this study, 2 patients with lumbar suppurative spondylitis experienced different degrees of lower extremity numbness postoperatively and recovered with conservative treatment. Second, when an infectious lesion is located in the thoracic vertebra, the nerve root can be ligated at the T10 level and above to enlarge the operating field. Surgery should be performed close to the vertebral body to avoid pleural effusion due to rupture. In this study, two patients experienced pleural effusion, which was cured after anti-infection, lung function exercise, and closed thoracic drainage. There was no significant correlation between postoperative pleural effusion and the use of costal bone graft. The occurrence of pleural effusion is mainly related to the severity of local infection and intraoperative operation. After careful analysis, the pleural effusion cases are likely related to the surgical approach in the thoracic region rather than the type of bone graft. When operating in the thoracic area, the risk of pleural injury exists during the process of exposing the operative field, especially when dealing with lesions near the thoracic cavity. The rib graft is mainly used for providing bone material for fusion, and there is no direct causal relationship between it and pleural effusion. Third, when removing contralateral lesions, the operating table can be tilted to the contralateral side to increase exposure, and removal of the epidural abscess can be accomplished by partial excision of the articular process and lamina. Fourth, incidental dural lesions should be avoided during surgery to prevent suppurative meningitis.

The results of this study may not be directly generalized worldwide. The incidence and characteristics of thoracic and lumbar suppurative spondylitis can vary in different regions due to differences in population demographics, living environments, and medical conditions. For example, in some areas with poor medical resources, the timely diagnosis and treatment of the disease may be affected, which could lead to different treatment outcomes. In addition, genetic factors and the prevalence of drug - resistant bacteria in different regions may also influence the treatment effect. Therefore, further multi - center and large - sample studies are needed to verify the universality of these results.

This study has several limitations. First, it is a retrospective case - control study, which may be affected by selection bias. The patients included in the study were from a single center, and the sample size is relatively small, which may limit the representativeness of the results. Second, the follow - up period is relatively short, and long - term outcomes such as the long - term stability of the spine and the recurrence rate of the disease need to be further observed. Third, the use of a single database may lead to incomplete data collection, which may also affect the accuracy of the research results.

Conclusion

In conclusion, the one - stage posterior debridement approach combined with autogenous bone grafting and internal fixation via the multifidus and longissimus interspaces shows promising results in the treatment of adul single - level thoracic and lumbar suppurative spondylitis. It can effectively achieve spinal cord decompression, focal debridement, kyphosis correction, and spinal stability reconstruction while protecting paravertebral muscles and posterior ligament complexes. However, considering the limitations of this single - center retrospective study with a small sample size and short follow - up period, further large - scale, multi - center, and long - term follow - up studies are necessary to confirm its long - term efficacy and safety.

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Author contributions

YJG: collect data, analyze data, create graphs, make tables, write the first draft, and revise the manuscript. YBY: collect data. ZC: collect data, analyze data, create graphs, make tables. DXF: supervise and provide suggestions. FL: provide ideas for the paper, supervise, and revise the article.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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