Clinical Results Of A Lamina With Spinous Process And An Iliac Graft As Bone Grafts In The Surgical Treatment Of Single-Segment Lumbar Pyogenic Discitis: A Retrospective Cohort Study

Weiyang Zhong
Chongqing Medical University First Affiliated Hospital
Xinjie Liang
Chongqing Medical University First Affiliated Hospital
Xiaolin Wang
Chongqing Medical University First Affiliated Hospital
Ke Tang
Chongqing Medical University First Affiliated Hospital
Tianji Huang
Chongqing Medical University First Affiliated Hospital
Xiaoji Luo (cy2982@163.com)
Chongqing Medical University First Affiliated Hospital
Zhengxue Quan
Chongqing Medical University First Affiliated Hospital
Dianming Jiang
Chongqing Medical University First Affiliated Hospital

Research article

Keywords: Bone graft, lumbar pyogenic discitis, Spinous process, lamina, iliac graft

Posted Date: July 29th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-49502/v1

Abstract

Background: A retrospective study investigated and compared the results of a lamina withspinous process (LSP) and an iliac graft (IG) as bone grafts in single-segment lumbar pyogenic discitis (LPD) through one-stage-posterior-only approach with radical debridement and internal instrumentation.

Methods: Data from 37 patients were reviewed. A LSP was placed in 17 patients (group A), and an IG was implemented in 20 patients (group B). The surgery time, surgery hemorrhage, hospital stay, drainage, and follow-up (FU) were reviewed. The visual analogue scale (VAS), Oswestry Disability Index (ODI), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) level, segmental angle, intervertebral height and bony fusion time were compared preoperatively and at the final FU.

Results: All patients were followed-up for a mean of 27.94±2.35 months in group A and 30.29±1.89 months in group B, without a difference. The mean age was younger in group A than in group B ($P<0.05$). The surgery time, surgery hemorrhage, and hospitalization cost were lower in group A than in group B ($P<0.05$), except for the hospital stay and drainage time. Fever occurred in 10 patients in group A and 12 patients in group B. The ESR, CRP level, and VAS and ODI scores were significantly decreased, and there were no significant differences between the groups at the final FU. The distribution of bacterial agents in blood culture was 1 case of *Aerobacter cloacae*, 2 of *Staphylococcus aureus*, 2 of *Escherichia coli*, and 1 of *Streptococcus viridis* in group A and 1 of S. aureus、1 of *Staphylococcus warneri* and 2 of *Klebsiella pneumoniae* in group B. Pyogenic infection was observed in the pathological findings of all patients. No significant difference was found in the mean segmental angle or mean intervertebral height preoperation and at the final FU between the groups.

Conclusion: The use of LSP as a new bone graft is reliable, safe, and effective for surgical management for the LPD while surgery is proposed as a good management strategy for LPD in carefully selected patients.

Background

Lumbar pyogenic discitis (LPD) is difficult to diagnose because of its insidious start and indolent course, and it is a rare infection with an increase in the growing number of human immunodeficiency virus (HIV) coinfections, bacterial resistance and population migration[1–3]. The diagnosis of LPD is usually delayed a few months and may initially be misdiagnosed and mishandled as a degenerative disease[3–4]. LPD is often monomicrobial and most commonly due to *Staphylococcus aureus*. The management should be depend on the results of culture and in vitro susceptibility test[5–6].

Most patients are cured after 6 weeks or more of antimicrobial therapy, but a few patients may require surgical debridement and/or spinal reconstruction during or after antimicrobial therapy[5–6]. LPD can result in destructive lesions or neurological impairment, which is indicated for surgery. Although the surgical approaches for LPD are controversial, surgical treatment can provide better pain relief and quality of life. After meticulous and radical debridement, bone grafts play a key role in surgery by curing

LPD, as they can rebuild spinal stability and maintain alignment when patients suffering from neurological deficits are indicated for surgery[7–10]. In our study, we compared a lamina with spinous process (LSP) and an iliac graft (IG) as bone grafts in treating single-segment LPD through a posterior-only approach with debridement and internal instrumentation.

Methods

Patient selection

From January 2014 to December 2016, 37 patients with single-level LPD were reviewed retrospectively and were divided into two groups. When we communicated with patients before surgical management, the advantages and disadvantages of the therapy plans with the two types of bone grafts were fully introduced so that the patients could choose the right therapy. The surgeries were performed by the same senior spine team. The inclusion criteria were as follows: adult single-level LPD, a one-stage-posterior-only approach, internal fixation and fusion, and patients indicated for surgery due to failure to respond to antimicrobial treatment or source control, neurological deficits, or bone destruction affecting stability. The exclusion criteria were as follows: spinal tuberculosis, fractures, spine metastasis and cancer.

Surgical procedure

After the successful general anaesthesia and the patients placed in the prone position, through a midline incision, the posterior spinal elements including the lamina and facet joints were fully exposed. The pedicle screws were fixed exactly according to imaging and C-arm X-ray findings. Decompression and complete debridement were performed. The LSP or IG was cut off for complete resection, and they were trimmed for a suitable bone graft (Figure 1). According to the area remaining after complete debridement, one graft was implanted and appropriately locked with strong instrumentation. Vancomycin (1.0 g) mixed with gelatine was used locally around the graft. The drainage and lavage with saline were applied postoperatively. The specimens were sent for bacterial culture and pathological testing. The patients wore a brace for 6-8 weeks after surgery.

Postoperative care

Rehabilitation therapist-guided ambulation exercises were started 1 week after the operation.All the patients were recommended to undergo antimicrobial therapy for 8-12 weeks after surgery. All patients underwent clinical and imaging examinations 1 week, 12-week, 6-month, 1-year and annually after surgery.

Follow-up index

The following data were recorded perioperatively and during FU. (1) The surgery time, surgery hemorrhage, hospital stay, drainage, the FU time and bony fusion time were recorded. (2) Pathological findings: tissue edema or inflammatory cell infiltration.3The segmental angle was recorded. According to the Cobb method, the segmental angle was defined as the angle formed between the superior endplate

of the upper vertebral body and the inferior endplate of the lower vertebral body. (4) The intervertebral height was defined as the vertical height between the upper and lower vertebral bodies of the fused segment on lateral X-ray. (5) The VAS and ODI were recorded. (6) The ESR and CRP were recorded. Bony fusion was evaluated by X-ray and CT when necessary, by Bridwell criteria[11]. All radiographic data and measurements were reviewed by one senior spine surgeon and one senior radiologist.

Statistical analysis

The statistical analysis was performed using the Statistical Analysis System (SAS Institute Inc., Cary, NC, USA). The results are expressed as the mean ± SD. Differences with P values < 0.05 were considered statistically significant.

Results

Clinical assessments

All patients were followed up on average of 27.94±2.35 months in group A and 30.29±1.89 months in group B,with no difference (P>0.05).The mean age was younger in group A than in group B (P<0.05).The surgery time, blood loss, and hospitalization cost were lower in group A than in group B (P<0.05), except for the hospital stay and drainage time (Table 1). Fever occurred in 10 patients in group A and 12 patients in group B, without a difference (P>0.05). The mean time of antibiotic therapy before surgery was 17.62±3.76 days in group A and 13.86±4.71 days in group B, without a difference (P>0.05). The ESR, CRP level, and VAS and ODI scores were significantly decreased, and there were no significant differences between the groups at the final FU (Table 2). The distribution of bacterial agents in blood culture was 1 case of *Aerobacter cloacae*, 2 cases of *Staphylococcus aureus*, 2 cases of *Escherichia coli*, and 1 case of *Streptococcus viridis* in group A and 1 case of *S.aureus*, 1 case of *Staphylococcus warneri* and 2 cases of *Klebsiella pneumoniae* in group B (Table 3). In stool, urine or surgical material culture, no bacterium was isolated. Pyogenic infection was observed in the pathological findings of all the patients (Figure 2).

Radiological assessments

LPD was fully cured, and the bone fusion at a mean time of 11.30±4.751 months in group A was longer than that in group B (6.80±1.50) (Figures 3, 4). No significant differences were found in the mean segmental angle or mean interventricular height preoperation and at the final FU between the groups (P>0.05).

Complications

Some postoperative complications occurred, such as superficial infection (4 cases in group A and 5 in group B), which healed with dressing changes.

Table 1
Information of the patients

	Group A	Group B	P value
No. of patients (n)	17	20	
Male/female (n)	6/11	10/10	
Mean age (years)	40.71 ± 17.04	59.18 ± 13.71	< 0.0001
Hospital stay (days)	23.50 ± 9.54	23.10 ± 10.04	0.9147
Surgery time (minutes)	177.39 ± 39.29	231.70 ± 65.31	< 0.0001
Hospitalization cost	74881 ± 34374	78339 ± 25327	< 0.0001
Blood loss (ml)	400.00 ± 357.3	532.40 ± 303.60	< 0.0001
Drainage time (days)	6.21 ± 0.90	7.12.±0.85	0.2985
Mean fusion time	11.30 ± 4.75	6.80 ± 1.50	< 0.0001
(months)	10/17	12/20	0.9441
Fever	17.62 ± 3.76	13.86 ± 4.71	0.4328
Antibiotic therapy	4	3	
time before surgery (days)	1	2	
Affected levels	1	2	
L1-2	8	9	
L2-3	3	4	
L3-4			
L4-5			
L5-S1			

Table 2
Clinical and radiographic outcomes

Parameter	Group A	Group B	P value
ESR	56.43 ± 37.47	64.76 ± 33.47	0.5183
before treatment	14.93 ± 3.79	15.24 ± 3.15	0.8074
Final FU	34.25 ± 31.23	34.49 ± 26.14	0.8441
CRP	5.07 ± 0.75	5.82 ± 0.38	0.0619
Before treatment			
Final FU			
VAS	6.95 ± 0.94	6.5 ± 0.75	0.8023
before treatment	1.95 ± 0.69	1.58 ± 0.95	0.9607
Final FU			
ODI	40.95 ± 4.10	41.05 ± 4.25	0.8901
before treatment	5.10 ± 1.50	5.60 ± 1.85	0.6675
Final FU			
Segmental angle (°)	15.85 ± 3.60	14.75 ± 4.15	0.1955
before treatment	10.25 ± 2.05	9.08 ± 3.45	0.0980
Final FU			
Intervertebral height (cm)	10.30 ± 2.80	11.50 ± 2.10	0.1065
before treatment	9.50 ± 1.05	10.10 ± 1.30	0.5420
Final FU			

ODI: Oswestry Disability Index; VAS: visual analogue scale; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; FU: follow-up

Table 3
Serological and bacteriological findings

Parameter	Group A	Group B	P value
Blood culture	6/17	4/20	0.3098
Aerobacter cloacae	1	1	0.9899
Staphylococcus aureus	2	1	
Escherichia coli	2	2	
Streptococcus viridis Staphylococcus warneri	1	20/20	
Klebsiella pneumoniae	17/17		
Pathological findings			

Discussion

LPD diagnosis can be very difficult, especially in a resource-poor environment. This challenge stems from the relative rarity of the disease, a much higher incidence of non-specific back pain in the whole population, changes in protein expression, non-pathogenic imaging and positive rates from culture[11–12]. The main means of diagnosis are spinal imaging and spinal biopsy materials for microbiological examination and ideal histopathology. In any infectious disease, the therapy should be based on the results of culture and in vitro susceptibility testing. According to Infectious Diseases Society of America(IDSA) clinical practice guideline for the diagnosis and treatment of native vertebral osteomyelitis in adults, LPD is frequently monomicrobial and most often due to *Staphylococcus aureus*[5–6, 13–14]. The local administration of VCM was usually performed for better control of infection. However, in our study, although blood culture isolated the bacterium, the positive culture rate was 35.2% in group A and 20% in group B, but there were no findings in the stool, urine or surgical material culture[15–16]. There were only 3 cases of *Staphylococcus aureus* in the two groups. Perhaps because the regimens of antibiotic therapy and the methods of administration were empirical, in the study, the mean times of antibiotic therapy before surgery, which were 17.62 ± 3.76 days in group A and 13.86 ± 4.71 days in group B, could explain why we had more difficulty with the diagnosis as well as the morbidity and mortality of effective treatment, and the culture positive rate was low.

Most patients are cured with a course of 6 weeks or more of antimicrobial therapy, but a few patients may need surgical debridement and/or spinal reconstruction during or after antimicrobial therapy. After complete lesion debridement, numerous interbody bone grafts are applied to recover and reconstruct spinal stability[17–19]. Titanium mesh cages(TMCs) filled with autologous bone grafts have been widely applied and could achieve high bony fusion rates. However, the surgical planning and results could be affected by the subsidence, stress shielding, and radio-opacity[20]. Thus, our research aimed to find a new bone graft that could provide biomechanical support and achieve bony fusion to reduce the incidence of complications. The use of a LSP as the bone graft has several advantages. Firstly, compared

with the IG, the LSP were more minimally invasive, shorten the surgery time, and reduce postoperative complication rates. Secondly, in the study, the mean time of bone fusion was 11.30 ± 4.751 months in group A, which was longer than that in group B (6.80 ± 1.50). Although the LSP gained a longer time of bone healing, with the correction of segmental kyphosis, there was no significance among the groups. Hence, the LSP could provide excellent biomechanical support, strength, and bone fusion properties. Furthermore, the LSP, as an autologous bone graft, has a cortical bony structure supporting the bone defect space and can ensure and maintain segmental stability and alignment. After the surgery, the VAS and ODI scores were improved significantly, which improved the life quality of the patients.

Although the diagnosis of LPD is very difficult, some clues can be identified: severe low back pain, fever, increasing infection indexes, magnetic resonance imaging (MRI), C-arm-guided biopsy, and clear pathogenic bacteria from cultures[17–18, 21–23]. However, there is a50% misdiagnosis rate,and pathological findings are still the gold standard despite the culture of blood, urine, stool, or surgical tissue being negative. MRI is considered the modalityof choice for radiographic diagnosis, especially in severe lower back pain. Previous studies have reported an MRI sensitivity of 96%, a specificity of 93% and an accuracy of 94% in LPD, and MRI plays the key role in the continuous observation of LPD[24–27].

However, we declare that the study had a few limitations. First, the retrospective natureof the small-sample study may be associated with bias, more patients need to be included in the study. Second, the single LSP as a bone graft had a long bony fusion time and may be a risk factor for the delay of bony fusion.Third, the study did not consider intra- or inter-observer differences, which was associated with bias. In the future, prospective, randomized studies with long-term follow-up periods are needed.

Conclusion

Our study results showed that the use of a LSP could be a new bone graft in treatingsingle-segment LPD in carefully selected patients, resulting in good bone fusion and spinal stability restoration,as it could be a reliable, safe, and effective bone grafting method.

Abbreviations

LSP: spinous process; IG: iliac graft; VAS: visual analog scale; ODI: Oswestry Disability Index ; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; FU: follow-up: LPD: Lumbar pyogenic discitis: HIV: human immunodeficiency virus; Vancomycin: VCM

Declarations

Ethics approval and consent to participate

The Institutional Review Board of the First Affiliated Hospital of Chongqing Medical University approved this study and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before their data were stored in our hospital database.

Consent for publication

This paper is approved by all authors for publication.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

The study was supported by the medical senior talents programme of Chongqing(2019GDRC001).

Authors' contributions

WYZ, XjiL designed the study. WYZ, XjieL, XLW and KT collected the data. TJH , XjiL, ZXQ and DMJ performed the statistical analysis. WYZ and XjieL wrote the manuscript. All authors read and approved the final manuscript.

Acknowledgements

WYZ acknowledges KT and XLW for the help in the study.

Author details

1.Department of Orthopedic surgery, The First Affiliated Hospital of Chongqing Medical University, Chongqing, China

2.Department of Pain Management, The First Affiliated Hospital of Chongqing Medical University, Chongqing, China

3.Department of Orthopedic Surgery, People's Hospital of Yubei District, Chongqing, China

4. Department of Orthopedic Surgery, The Third Affiliated Hospital of Chongqing Medical University, Chongqing, 400042, China

※ Contribute equally

Correspondence: Prof. Xiaoji Luo, Department of Orthopedic Surgery, The First Affiliated Hospital of Chongqing Medical University (cy2982@163.com)

References

1. Hadjipavlou AG, Mader JT, Necessary JT, et al. Hematogenous pyogenic spinal infections and their surgical management. Spine (Phila Pa 1976). 2000;25:1668–79.
2. Kehrer M, Pedersen C, Jensen TG, et al. Increasing incidence of pyogenic spondylodiscitis: a 14-year population-based study. J Infect. 2014;68:313–20.
3. Kapsalaki E, Gatselis N, Stefos A, et al. Spontaneous spondylodiscitis: presentation, risk factors, diagnosis,management, and outcome. Int J Infect Dis. 2009;13:564–9.
4. Cheung WY, Luk KD. Pyogenic spondylitis. Int Orthop. 2012;36:397–404.
5. Gras G, Buzele R, Parienti JJ, et al. Microbiological diagnosis of vertebral osteomyelitis: relevance of second percutaneous biopsy following initial negative biopsy and limited yield of post-biopsy blood cultures. Eur J Clin Microbiol Infect Dis. 2014;33:371–5.
6. Berbari EF, Kanj SS, Kowalski TJ, et al. 2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults. Clin Infect Dis. 2015;61(6):e26–46.
7. Gras G, Buzele R, Parienti JJ, et al. Microbiological diagnosis of vertebral osteomyelitis: relevance of second percutaneous biopsy following initial negative biopsy and limited yield of post-biopsy blood cultures. Eur J Clin Microbiol Infect Dis. 2014;33:371–5.
8. Lin CP, Ma HL, Wang ST, et al. Surgical results of long posterior fixation with short fusion in the treatment of pyogenic spondylodiscitis of the thoracic and lumbar spine: a retrospective study. Spine (Phila Pa 1976). 2012;37:E1572–9.
9. Nasto LA, Colangelo D, Mazzotta V, et al. Is posterior percutaneous screw-rod instrumentation a safe and effective alternative approach to TLSO rigid bracing for single-level pyogenic spondylodiscitis? Results of a retrospective cohort analysis. Spine J. 2013;14:1139–46.
10. von Stechow D, Rauschmann MA. Effectiveness of combination use of antibiotic-loaded PerOssal with spinal surgery in patients with spondylodiscitis. Eur Surg Res. 2009;43:298–305.
11. Koptan W, Elmiligui Y, Elsharkawi M. Single stage anterior reconstruction using titanium mesh cages in neglected kyphotic tuberculous spondylodiscitis of the cervical spine. Eur Spine J. 2011;20:308–13.
12. Eck KR, Bridwell KH, Ungacta FF, et al.Analysis of titanium mesh cages in adults with minimum two-year follow-up. Spine (Phila Pa 1976),2000,25(18):2407–2415.
13. Si M, Yang ZP, Li ZF, et al. Anterior versus posterior fixation for the treatment of lumbar pyogenic vertebral osteomyelitis. Orthopedics. 2013;36:831–6.
14. Gasbarrini A, Boriani L, Nanni C, et al. Spinal infection multidisciplinary management project (SIMP): from diagnosis to treatment guideline. Int J Immunopathol Pharmacol. 2011;24:95–100.
15. Gelfand MS, Cleveland KO. Treatment of vertebral osteomyelitis. J Infect. 2014;68:299–300.
16. Alvi AA, Raees A, Khan Rehmani MA, et al. Magnetic resonance image findings of spinal tuberculosis at first presentation. Int Arch Med. 2014;7:12.

17. Murillo O, Roset A, Sobrino B, et al. Streptococcal vertebral osteomyelitis: multiple faces of the same disease. Clin Microbiol Infect. 2014;20:033–8.
18. Berbari EF, Kanj SS, Kowalski TJ, et al. 2015 Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults. Clin Infect Dis,2015,61: e26-46.
19. Chew, FSKline, MJ. Diagnostic yield of CT-guided percutaneous aspiration procedures in suspected spontaneous infectious diskitis. Radiology. 2001;218:211–4.
20. Shoji H, Urakawa T, Watanabe K, et al. Clinical features, outcomes, and survival factor in patients with vertebral osteomyelitis infected by methicillin-resistant staphylococci. J Orthop Sci. 2016;21:282–6.
21. Zhang ZX, Li, THao, DJ. Single-stage Treatment of Osteomyelitis of the Cervical Spine Using Anterior Instrumentation and Titanium Mesh Cages. Spine (Phila Pa 1976),2016,41: E949-954.
22. Nickerson, EKSinha, R. Vertebral osteomyelitis in adults: an update. Br Med Bull. 2016;117:121–38.
23. Skovrlj B, Guzman JZ, Caridi J, et al. Posterior-Only Circumferential Decompression and Reconstruction in the Surgical Management of Lumbar Vertebral Osteomyelitis. Global Spine J. 2016;6:e35–40.
24. Gouliouris T, Aliyu SH, Brown NM. Spondylodiscitis: update on diagnosis and management. J Antimicrob Chemother. 2010;65(Suppl 3):iii11–24.
25. Ledermann HP, Schweitzer ME, Morrison WB, Carrino JA. MR imaging findings in spinal infections: rules or myths? Radiology. 2003;228:506–14.
26. Kowalski TJ, Layton KF, Berbari EF, et al. Follow-up MR imaging in patients with pyogenic spine infections: lack of correlation with clinical features. AJNR Am J Neuroradiol. 2007;28:693–9.
27. Tsai T, Yang S, Niu C, et al. Early surgery with antibiotics treatment had better clinical outcomes than antibiotics treatment alone in patients with pyogenic spondylodiscitis: a retrospective cohort study. BMC Musculoskelet Disord. 2017;18:175.

Figures

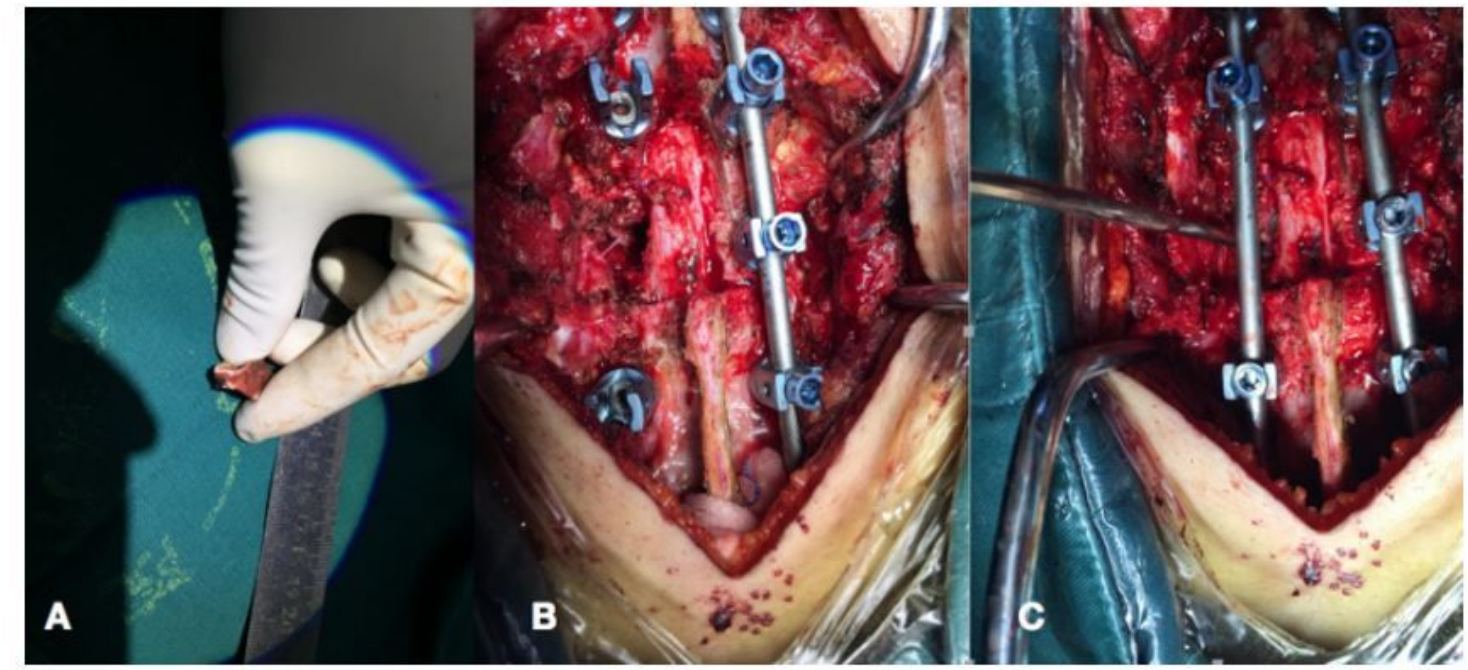

Figure 1

Photographs of one LSP that was implanted (A, B), and the LSP was verified for stability(C).

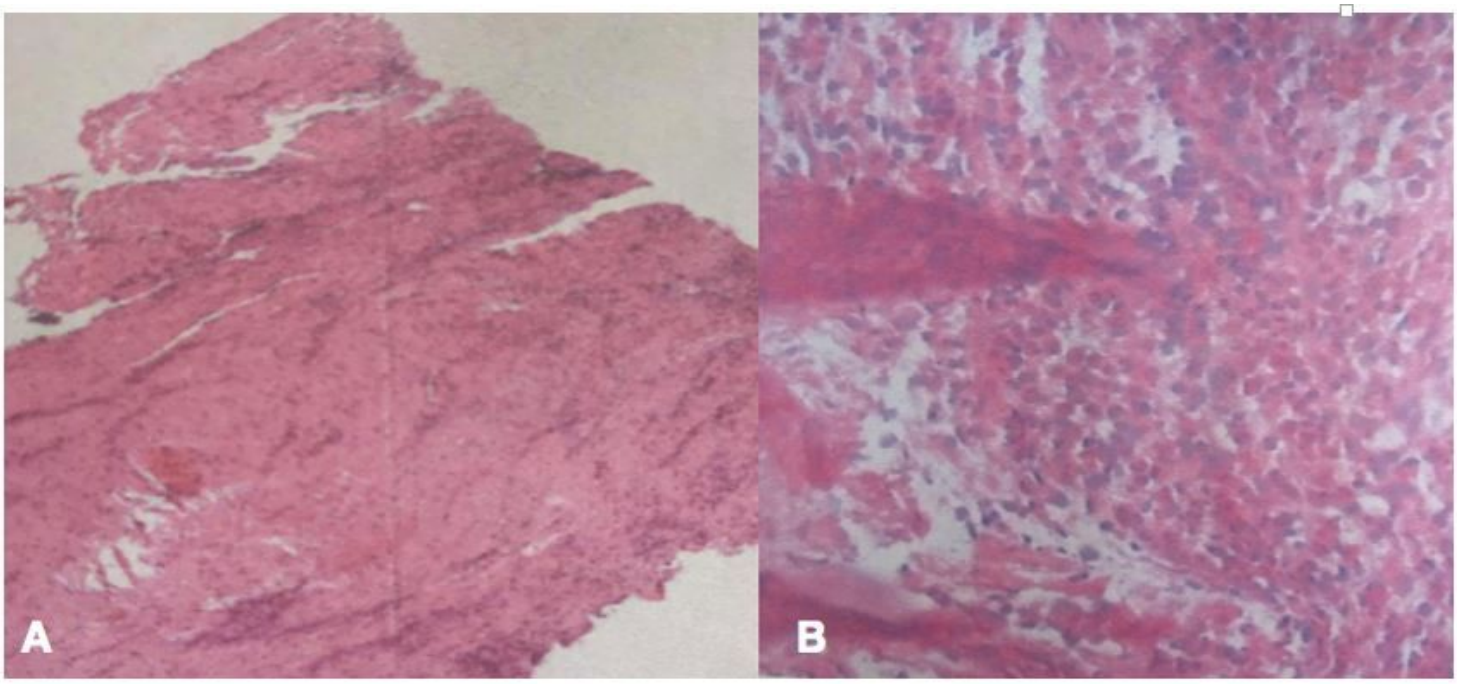

Figure 2

The pathological findings demonstrated oedema and inflammatory cell infiltration in the tissue

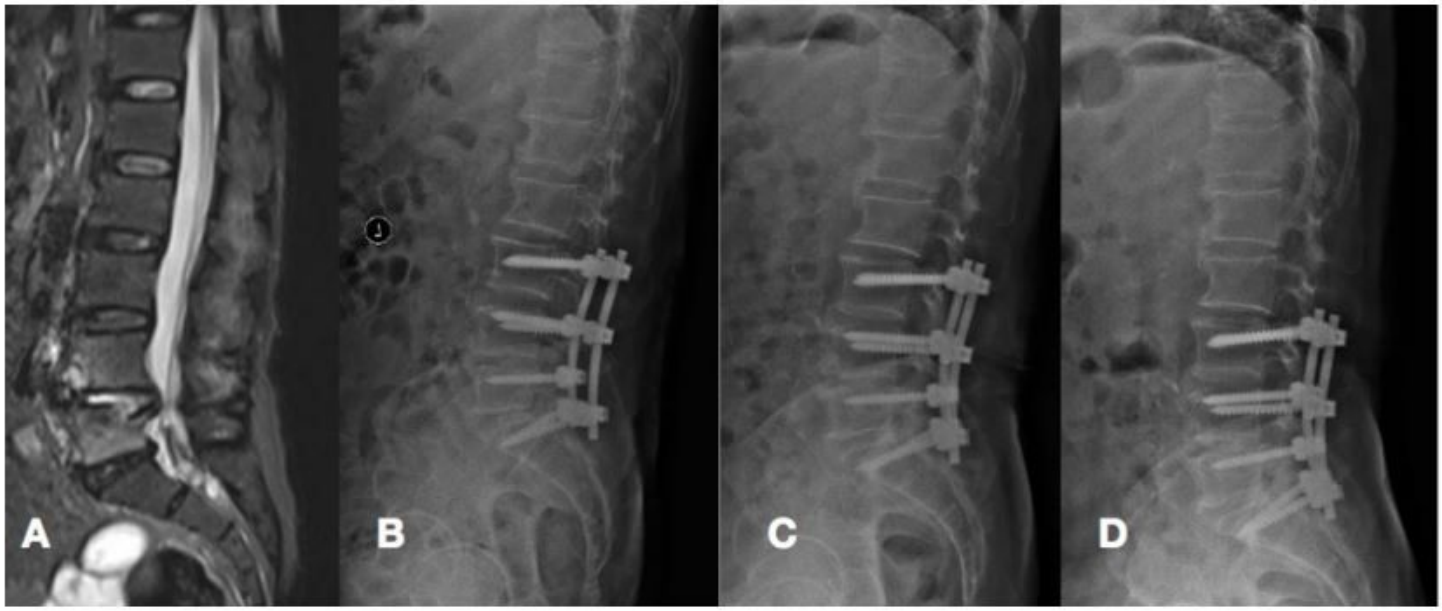

Figure 3

A 40-year-old female patient with lumbar pyogenic discitis (L4-5) underwent posterior debridement and decompression combined with instrumentation with an IG. (A) Preoperative computed tomography (MRI) showed bone destruction of the L4-5 disc and compression of the spinal nerves. (B, C) Six-month and 12-month postoperative X-rays showed maintained correction. (D) Three-year postoperative X-rays showed that solid bone fusion had been achieved.

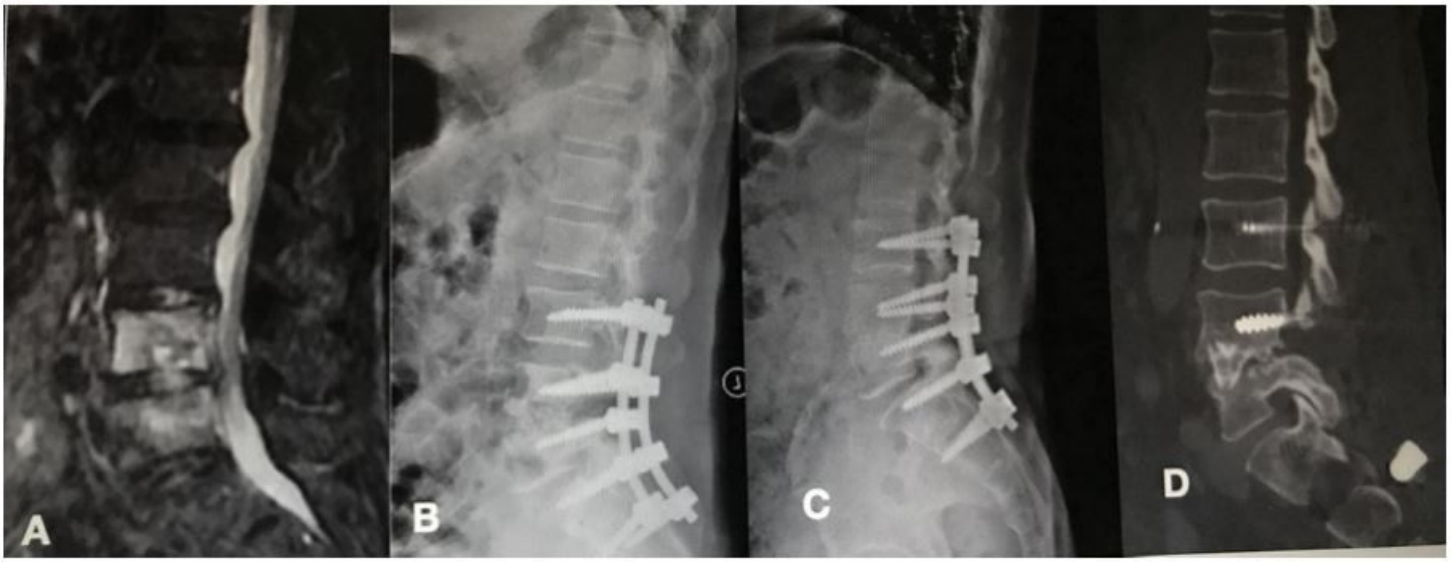

Figure 4

A 30-year-old man with lumbar pyogenic discitis (L4-5) underwent single-segment posterior debridement and decompression combined with internal fixation with an LSP. (A) Pretreatment MRI showed the destruction of the L4-5 disc and concomitant compression of the spinal nerves. (B) Twelve-month

postoperative X-rays showed maintained correction. (C, D) At the 32-month follow-up, plain X-ray and CT showed maintenance of the correction and solid fusion.