Comparison of Long-term Clinical and Radiographical Outcomes Between the Anterior and Combined Anterior and Posterior Approaches for Treating Lumbosacral Tuberculosis

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Abstract

Background: Both the anterior and combined anterior and posterior approaches have been used to treat lumbosacral tuberculosis. However, long-term follow-up studies of each approach have not been conducted. We aimed to compare the long-term clinical and radiographical outcomes between the two approaches.

Methods: We included 49 patients with a minimum 6-year follow up between January 2008 to March 2012. Twenty-four patients underwent the anterior approach (group A) and 25 underwent the combined anterior and posterior approach (group B). We collected clinical data, such as visual analogue scale scores, Oswestry disability index scores and neurological status, and radiographical data, such as lumbosacral angle and lumbar lordosis. Furthermore, operative time, length of stay, and intraoperative and postoperative blood loss (IBL, PBL) were recorded.

Results: Both groups had satisfactory clinical and radiographical outcomes until follow up. All patients achieved bony fusion, and no group differences were found in any of the clinical indices. Both groups corrected and maintained lumbosacral angle and lumbar lordosis. However, operative time, length of stay, maximum Hb drop, IBL, and PBL of group A (140.63 ± 24.73 min, 12.58 ± 2.45 d, 28.33 ± 9.70 g/L, 257.08 ± 110.47 mL, and 430.60 ± 158.27 mL, respectively) was significantly lower than those of group B (423.60 ± 82.81 min, $p < 0.001$; 21.32 ± 3.40 d, $p < 0.001$; 38.48 ± 8.03 g/L, $p < 0.001$; 571.60 ± 111.04 mL, $p < 0.001$; and 907.01 ± 231.99 mL, $p < 0.001$).

Conclusions: This retrospective study demonstrated long-term efficacy of the anterior approach, which was as effective as that of the combined anterior and posterior approach, with the advantage of less trauma.

Background

Lumbosacral junction (L5–S1) tuberculosis (LSTB) occurs in 2–3% of patients with spinal tuberculosis (1). Specific and effective antituberculous chemotherapy is the mainstay of treatment; however, if non-surgical treatments fail, surgical interventions are considered. Because of the unique mechanical properties and complex anatomical structure, surgery in this region remains complicated and controversial (2–5).

The one-stage posterior approach for treatment of LSTB can provide adequate internal fixation and stability reconstruction (4, 6, 7). However, the posterior approach offers no advantage on debridement (6, 8). Patients with LSTB usually experience significant abscesses, and the destruction is often concentrated on the anterior vertebral columns. To achieve adequate lesion debridement, many surgeons now implement the combined anterior and posterior approach (9, 10), although this approach requires more extensive surgery, which usually results in more substantial trauma.

Moreover, some surgeons have reported that outcomes similar to the combined anterior and posterior approach can be achieved with the anterior only approach (11, 12). It is worth noting that the internal fixation device used in both studies was the screw-plate system, and that both studies had relatively small sample sizes and short follow-up periods. Additionally, in some patients, the low bifurcation of iliac vessels makes the use of these devices more dangerous, which limits the application of the anterior approach. To reduce surgical trauma and risk, we employed the one screw fixation approach instead of the screw-plate system. To the best of our knowledge, this is the first study that uses the anterior approach without rigid fixation for the treatment of LSTB. The aim of our study was to compare long-term clinical and radiographical outcomes between patients who underwent the anterior one screw fixation approach with those who received the combined anterior and posterior approach.

Methods

This retrospective, clinical, and comparative study was approved by the Ethics Committee of the West China Hospital, and informed consent was obtained from all the participants in the study. All methods in the study were carried out in accordance with the Helsinki guidelines and declaration. We reviewed patients who had received surgical treatment for LSTB from January 2008 to March 2012. Diagnosis was based on medical history, clinical symptoms, laboratory results, radiographical evidence, and was confirmed by the examination of surgical biopsy specimens, acid-fast staining, bacterial cultures, or polymerase chain reaction. Indications of surgical procedure included: (1) persistent lower back pain related to instability and identified with pre-sacral or paraspinal abscess, (2) progressive neurological deficit, (3) presence of severe local deformity or deformity likely to progress, and (4) unresponsive to the anti-tuberculosis regimens. Exclusion criteria were as follows: (1) history of pelvic or lumbosacral surgery, (2) lumbosacral deformity caused by any other disease, such as adolescent scoliosis or ankylosing spondylitis, and (3) failure to complete follow up. The enrolled patients were then divided into group A and group B based on the different surgical approaches. In fact, it is difficult to randomly select a surgical treatment method clinically. In this study, most patients in group A (anterior) were collected after 2010, but the majority of patients in group B (combined anterior and posterior) were collected earlier, before 2010.

Preoperative procedure

Chemotherapy was initiated immediately following diagnosis of LSTB. Standard four-drug therapy that included isoniazid (300 mg daily), rifampin (450 mg daily), ethambutol (1200 mg daily), and pyrazinamide (750 mg daily) was administered for at least 4 weeks before surgery. General nutritional treatment was also given throughout chemotherapy.

Surgical procedure

Anterior only approach

After administration of general endotracheal anesthesia, the patient was put in a supine position with the waist elevated by a pad. A median incision of 10 cm was made along the symphysis pubis to the umbilicus, with the sacral promontory as the center. The peritoneum and its contents were pushed inward to expose the anterior lumbosacral junction. We then identified the sacral promontory and iliac vascular bifurcation. When necessary, the middle sacral artery was ligated. Before dissection and traction of the prevertebral fascia and abscess wall, the abscess was confirmed by a syringe puncture. Curettes and rongeurs were used to eliminated pus, cheesy necrotic tissue, granulation tissue, necrotic bone, and the affected disc until we reached the bleeding bony surface. After gaining hemostasis, hydrogen peroxide and physiological saline were used for space irrigation until the wound was clear of residual tuberculous tissue. The spinal defect was measured, and an appropriately sized tricortical iliac crest bone was tightly punched into the L5–S1 bone groove. One cortical screw (diameter: 3.5 or 4.0 mm, Weigao, Shandong, China) was inserted through the ilium graft bone into the S1 vertebra to prevent graft backout (Fig. 1). After gaining hemostasis, streptomycin powder (1.0 g) and isoniazid (0.3 g) were administered locally. A local drainage tube was inserted before the incision was closed. All debrided specimens were analyzed for bacterial culturing and histopathological examination.

Combined anterior and posterior approach

All patients in the group B underwent the same method anteriorly as those in group A, except for screw implantation. For the posterior method, the patient was repositioned into a prone position, and their posterior lumbar region was sterilized and draped. Using a midline incision, an extraperiosteal dissection was made along both sides to expose the posterior spinal elements, which included the lamina, transverse processes, and facet joints. Then, the pedicle screws were inserted into the L5–S1 bone, and pre-bent rods were placed bilaterally to correct the local deformity through compression and stretching. Drainage tube insertion, incision closure, and local specimen were performed similarly to group A.

Postoperative procedure

The drainage tube was removed once the drainage volume was less than 30 mL per 24 h. Antituberculosis drugs (i.e., isoniazid, rifampicin, ethambutol, and pyrazinamide) were resumed for 3 months after surgery, which was followed by isoniazid, rifampicin, and ethambutol for another 9–15 months. Passive movements and functional limb exercises were carried out as early as possible. The use of a lower lumbar orthosis was continued for an average period of 3 months in both groups.

Clinical and radiographical evaluation

We collected data for operative time, intraoperative blood loss (IBL), postoperative blood loss (PBL), lowest postoperative hemoglobin (Hb), maximum Hb drop, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), length of stay, and complications. PBL was defined as total blood loss (TBL) minus IBL. PBV and TBL were calculated according to the formula of Nadler et al. (13) and Gross (14), respectively: PBV = k1 × height (m)^3 + k2 × weight (kg) + k3, where k1 = 0.3669, k2 = 0.03219, and k3 = 0.6041 for men and k1 = 0.3561, k2 = 0.03308, and k3 = 0.1833 for women; TBL = PBV × (Hct_{pre} – Hct_{post})/Hct_{ave}, where Hct_{pre} = preoperative hematocrit (Hct) level, Hct_{post} = Hct level on postoperative day two or three; Hct_{ave} = the average of Hct_{pre} and Hct_{post}. The volume of transfused allogenic red blood cells was also added to calculate TBL. Maximum Hb drop was defined as the difference between preoperative Hb and lowest postoperative Hb during hospitalization. American Spinal Injury Association (ASIA) scores, Visual Analogue Scale (VAS) scores, and Oswestry Disability Index (ODI) scores were recorded preoperatively and at the final follow up. The radiographical indices were as follows: lumbosacral angle, which was measured on lateral radiographs by drawing a line along the posterior border of the L5 and S1 (Fig. 2a); lumbar lordosis; screw related complications, and graft fusion status.

Statistical analysis

All data were analyzed using SPSS 23.0 software (SPSS Inc., Chicago, Illinois). Pearson's chi-square test and Fisher's exact test were used to analyze the qualitative variables. An independent samples t-test was used to perform between group comparisons. Cohorts that had non-normal data distributions were analyzed using the Mann-Whitney U test. Significance was determined by $p < 0.05$.

Results

General patient information

According to the screening criteria, a total of 49 patients were enrolled and divided into the anterior group (group A) and combined anterior and posterior group (group B) based on the different surgical approaches that patients received. Group A comprised 24 patients (14 male and 10 female) with a mean age of 37.58 years (range 22–51 years). In group B, there were 25 patients (13 male and 12 female) with a mean age of 35.84 years (range 25–55 years). The mean follow-up time across all patients was 76.57 months (range 72–95 months). The demographic data are summarized in Table 1. There were no significant differences in demographics between the two groups. Comparisons of the intraoperative and postoperative parameters between the two groups are shown in Table 2. Mean operative time and mean length of stay for group A (140.63 ± 24.73 min, 12.58 ± 2.45 d) were significantly shorter than those for group B (423.60 ± 82.81 min, $p < 0.001$; 21.32 ± 3.40 d, $p < 0.001$). Average intraoperative and postoperative blood loss of group A (257.08 ± 110.47 mL, 430.60 ± 158.27 mL) were also significantly lower than those of group B (571.60 ± 111.04 mL, $p < 0.001$; 907.01 ± 231.99 mL, $p < 0.001$).

Clinical and radiographical results

The ASIA scores before surgery are shown in Table 1. Patients with functional nerve impairment all recovered to grade E, and there were no significant differences between the two groups at any timepoint. The preoperative VAS scores were 6.71 ± 1.16 and 6.40 ± 1.08 for group A and AP, respectively, which decreased to 0.38 ± 0.58 and 0.48 ± 0.65 at the final follow up. There were no significant differences at any timepoint between the two groups. Similar results were observed for ODI scores (Table 3). The levels of ESR and CRP normalized within 3 months of surgery in all patients and were successfully maintained until the final visit. No significant differences were observed between the two groups at any timepoint (Fig. 4).

All patients achieved bony fusion according to the computed tomography (CT) assessments at follow up (Figs. 2 and 3). There were no significant differences in fusion time or grade between the two groups. Neither group showed screw related complications or recurrence on X-rays or CTs at the final follow up. Lumbosacral angle and lumbar lordosis significantly increased after surgery in both groups. In group A, mean lumbosacral angle increased from 19.41 ± 3.48° preoperatively to 28.70 ± 4.44° postoperatively and was maintained at the final follow-up (27.41 ± 3.76°), and in group B, the angle increased from 18.13 ± 4.17° preoperatively to 29.23 ± 3.00° postoperatively, which was maintained at 28.14 ± 3.32° at the final follow-up. A similar result was observed for lumbar lordosis. There were no significant group differences in either radiographical index at any timepoint (Table 3).

Postoperative complications

Surgery was successful in all patients, and no injuries occurred in the large vessels, nerves, or ureter. Neither group experienced severe complications, such as tuberculous peritonitis, ileus, erectile dysfunction, or retrograde ejaculation. One patient in group A developed superficial wound infections, which were successfully treated by regular dressing of the wound. One patient in group B presented with leakage of cerebrospinal fluid, which was treated by leaving the drainage tube in for longer.

Discussion

Lumbosacral junction tuberculosis accounts for only a small proportion of spine tuberculosis (about 2–3%), and treatment for this region remains controversial. Treatment is often associated with a large abscess in the presacral region, as well as destruction of the anterior vertebral columns. Both anterior only and combined anterior and posterior approaches have been used widely to achieve adequate lesion debridement and avoid draining the lesion into posterior areas (12, 15–18). At the 25-month follow up of 13 patients with LSTB who underwent the anterior approach, He et al. (15) concluded that the anterior approach was as effective as the combined anterior and posterior approach. Similarly, Sun et al. indicated satisfactory efficacy of the anterior approach at 40-month follow-up (12). However, their results were based on a relatively small sample size and a short follow up period. In the present study, we compared long-term outcomes between the two approaches for treating LSTB. Our results indicated satisfactory long-term efficacy without recurrence for both approaches. All patients obtained bony fusion, and there were no significant differences between the two groups for clinical or radiographical indices at follow up.

The lumbosacral junction (L5–S1) is the segment of the spine with the most significant stress concentration (19). In previous studies, surgeons have relied on rigid internal fixation, such as a screw-plate or dual screw-rod for restoring segmental stability and maintaining lumbosacral curvature (12, 15–18, 20). Moreover, they considered that a reliable fixation device is an important factor for achieving satisfactory outcomes when implementing the anterior approach in this region. However, performing internal fixation is difficult because of the complex anterior anatomy, which includes nerves, ureters, and major blood vessels. In our hospital, the screw-plate system (Synfix-LR, DePuy Synthes, West Chester, PA, USA), which is commonly utilized for reconstructing the L5–S1 region (20), was used previously for the anterior approach treatment for LSTB. However, we found it increased operation time and was more invasive, and we had concerns that the PEEK cage may increase the risk of recurrence. To minimize trauma, only a single screw was used to prevent graft displacement and stabilize the segment. The main concern of using this fixation method was that the autogenous cortical bone graft may not have sufficient structural strength and result in the loss of the lumbosacral lordosis correction. However, the lumbosacral angle of group A was successfully maintained until the final follow up. We speculate that the following factors may have contributed to the positive outcomes: a) the young age and lack of osteoporosis: the tricortical iliac crest bone grafts had adequate cross-sectional area and height which provided good biomechanical performance (21); b) the lumbosacral angle was corrected by positioning the patient in an extending posture; and c) those patients mainly present with anterior vertical destruction without significant kyphosis.

Previous research has reported that the advantages of the anterior approach are less trauma, relatively shorter hospital stay, shorter operative time, and lower blood loss. Our results are in line with these studies. PBL caused by continuous extravasation of the surgical site has proven to be considerable during various orthopedic surgeries and accounts for 39–85% of TBL (22–24). Previous studies have compared blood loss between the two approaches by focusing on IBL. However, to evaluate trauma more precisely, we also measured PBL of the two approaches. We found a mean Hb drop of 28.33 g/L and 38.48 g/L in groups A and AP, respectively. These figures are too large to be explained by IBL alone and therefore, indicate substantial PBL in both groups. We then calculated that mean PBL was 430.60 mL in group A and 907.01 mL in group B. In a prospective study, Somrgick et al. showed that PBL accounts for about 42% of TBL in primary spinal fusion surgery (25). However, the percentages of PBL in our study were 62% and 61% in groups A and AP, respectively, which is much higher than Somrgick et al.'s study. This may be because tuberculosis and drug side effects can lead to coagulation dysfunction, and thus prolong extravasation time and increase PBL. Moreover, debridement of the paraspinal abscess left several cavities in the surgical site, which provided additional space for postoperative bleeding. Therefore, during perioperative management of spinal tuberculosis patients, we advise paying more attention to postoperative Hb levels to avoid continuous decreases in Hb levels caused by PBL. We observed significantly lower Hb drop and PBL in group A than in group B. This was because the anterior only approach does not damage the posterior muscle, nor does it require decortication of the L5 and S1 lamina; less exposure and a smaller area of decortication help reduce PBL. Moreover, in a previous study, we found that there was a positive correlation between the number of pedicle screws and PBL (26). The anterior approach does not require pedicle screws and thus, results in lower PBL.

Although no complex instrumentation was used in group A patients, there remains the risk of complications related to approach used. We recommend the following for reducing intraoperative complications. Firstly, a complete radiology examination, especially computed tomographic angiography

(CTA), should be performed before surgery to fully inform the surgeon of the anatomical structures of the iliac vessels and lumbosacral region. Secondly, the abscess must be confirmed by a syringe puncture before blunt dissection and traction of the prevertebral fascia and abscess wall. Debriding the lesion within the abscess wall is also helpful in avoiding any iatrogenic injury. Lastly, to reduce risk of injury to the sympathetic trunk and hypogastric plexus, we recommend minimal cauterization and careful retraction. It is important to note that the anterior only approach is not successful in every patient with LSTB. For patients with advanced stage LSTB who present with major vertebral body loss, significant kyphosis, or multi-level involvement, the combined anterior and posterior approach should be given priority.

There are several limitations to our study. The retrospective design may lead to biased outcomes, and the sample size was relatively small. Therefore, prospective studies with larger sample sizes are needed.

Conclusions

This retrospective study demonstrated the long-term efficacy of the anterior approach with a single screw fixation for treating LSTB. We found that this method was as effective as that of the combined anterior and posterior approach but with the advantages of less IBL and PBL, shorter operative time, and reduced hospital stay.

Abbreviations

LSTB, lumbosacral junction tuberculosis

IBL, intraoperative blood loss

PBL, postoperative blood loss

TBL, total blood loss

Hb, hemoglobin

CRP, C-reactive protein

ESR, erythrocyte sedimentation rate

Hct, hematocrit

ASIA, American Spinal Injury Association

VAS, Visual Analogue Scale

ODI, Oswestry Disability Index

Declarations

Ethics approval and consent to participate

This retrospective clinical study was approved by the Ethics Committee of the West China Hospital, and informed consent was obtained from all the participants in the study. All methods in the study were carried out in accordance with the Helsinki guidelines and declaration.

Consent for publication

Not applicable

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors` contributions

Zhuang Zhang contributed to the design of this study; acquisition, analysis, and interpretation of data; writing and revising the manuscript.

Bo-wen Hu contributed to the acquisition and interpretation of data; revising the manuscript.

Lin-nan Wang contributed to the acquisition and interpretation of data.

Tao Li, contributed to the design of this study; analysis and interpretation of data.

Hui-liang Yang, contributed to the analysis and interpretation of data.

Li-min Liu, contributed to the design of this study; analysis and interpretation of data.

Yue-ming Song, contributed to the analysis and interpretation of data.

Zhong-jie Zhou, contributed to the design of this study; analysis and interpretation of data; revising the manuscript.

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Tables

Table 1

Patients’ demographic data.

	Group A (n=24)	Group B (n=25)	p
Age (years)	37.58±9.55	35.84±9.16	0.518
Gender (M/F)	14:10	13:12	0.656
Height (m)	1.67±0.07	1.65±0.07	0.392
Weight (kg)	60.46±6.45	57.60±7.04	0.145
BMI (kg/m2)	21.84±2.50	21.23±2.40	0.389
Pre-op Hb (g/L)	127.50±15.63	123.00±7.71	0.205
Pre-op Hct (%)	0.39±0.04	0.40±0.04	0.485
PBV (ml)	4080.82±475.41	3909.75±545.81	0.249
Number of affected vertebrae (n)			0.376
L5-S1	19	17	
L5-S2	5	8	
ASIA score			0.578
C	0	1	
D	5	6	
E	19	18	
Course of disease (month)	7.29±1.78	8.04±1.81	0.152
Follow-up period (month)	75.71±2.31	77.40±3.28	0.450

M/F, Male/Female; BMI, Body mass index, pre-op, preoperative; Hb, hemoglobin; Hct, hematocrit; PBV, patient`s blood volume; ASIA, American Spinal Injury Association

Table 2

The intraoperative and postoperative parameters.

	Group A (n=24)	Group B (n=25)	p
Operative time (min)	140.63±24.73	423.60±82.81	0.000
IBL (ml)	257.08±110.47	571.60±111.04	0.000
PBL (ml)	430.60±158.27	907.01±231.99	0.000
Lowest Hb level (g/L)	99.17±14.64	84.52±9.15	0.000
Max Hb drop (g/L)	28.33±9.70	38.48±8.03	0.000
Transfusion (n)			
Intraoperative	1	2	0.576
Postoperative	2	3	0.672
Length of stay (d)	12.58±2.45	21.32±3.40	0.000

IBL, intraoperative blood loss; PBL, postoperative blood loss; Hb hemoglobin; Hct, hematocrit

Table 3

Comparison of radiography and clinical data between the two groups.

	Group A (n=24)	Group B (n=25)	p
Preoperative			
Lumbosacral angle (°)	19.41±3.48	18.13±4.17	0.250
Lumbar lordosis (°)	29.21±6.38	29.86±4.70	0.687
VAS	6.71±1.16	6.40±1.08	0.340
ODI	37.46±5.18	39.64±6.47	0.200
1-week Postoperative			
Lumbosacral angle (°)	28.70±4.44*	29.23±3.00*	0.627
Lumbar lordosis (°)	39.49±6.37*	40.89±4.55*	0.376
6-year Follow-up			
Lumbosacral angle (°)	27.41±3.76*	28.14±3.32*	0.470
Lumbar lordosis (°)	37.64±4.17*	38.97±3.79*	0.247
VAS	0.38±0.58*	0.48±0.65*	0.554
ODI	2.96±0.95*	3.12±1.24*	0.612

VAS, Visual Analogue Scale; ODI, Oswestry Disability Index

*, P<0.05 compared to the preoperative parameter.

Figures

Figure 1

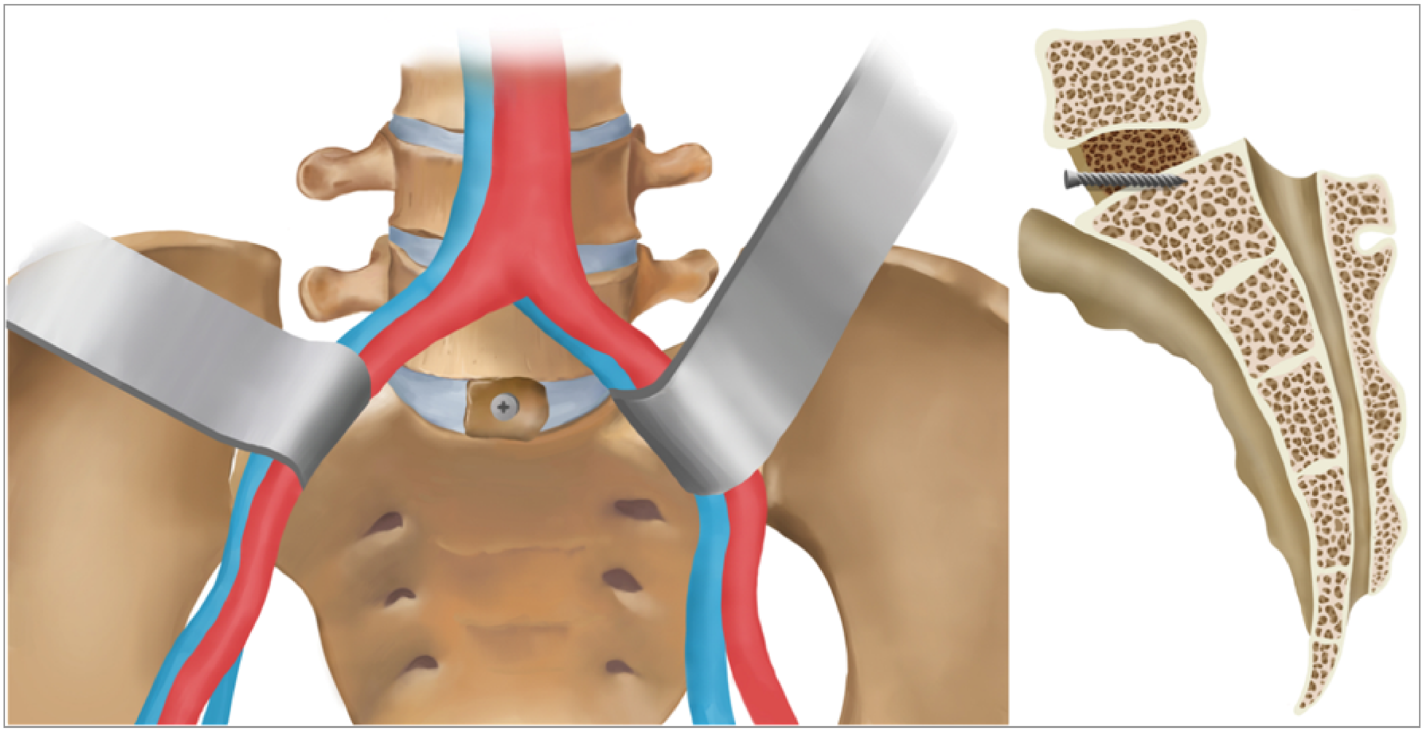

Figure 1

Schematic diagram of iliac bone grafting and screw fixation. After debridement, a tri-cortical iliac crest bone of appropriate size was tightly punched into the L5–S1 bone groove. One cortical screw (diameter: 3.5 or 4.0 mm) was inserted through the graft into the S1 vertebra in order to prevent the graft back out.

Figure 2

A 24-year-old male with LSTB who underwent combined anterior and posterior approaches. a-c Preoperative images show the L5-S2 lesion including bone destruction and paravertebral cold abscess formation. d Lateral X-ray revealing that lumbosacral angle was corrected at postoperatively. e, f Follow-up X-ray and CT at 95 months after surgery showed the well maintained lumbosacral and definite bone fusion.

Figure 3

A 38-year-old female with LSTB who underwent only anterior approach with a screw fixation. a-c Preoperative images show the L5-S2 lesion including bone destruction, pre-sacral and paravertebral cold abscess formation. d Lateral X-ray revealing that lumbosacral angle was corrected at postoperatively. e, f Follow-up X-ray and CT at 75 months after surgery demonstrate well maintained lumbosacral alignment and bony union.

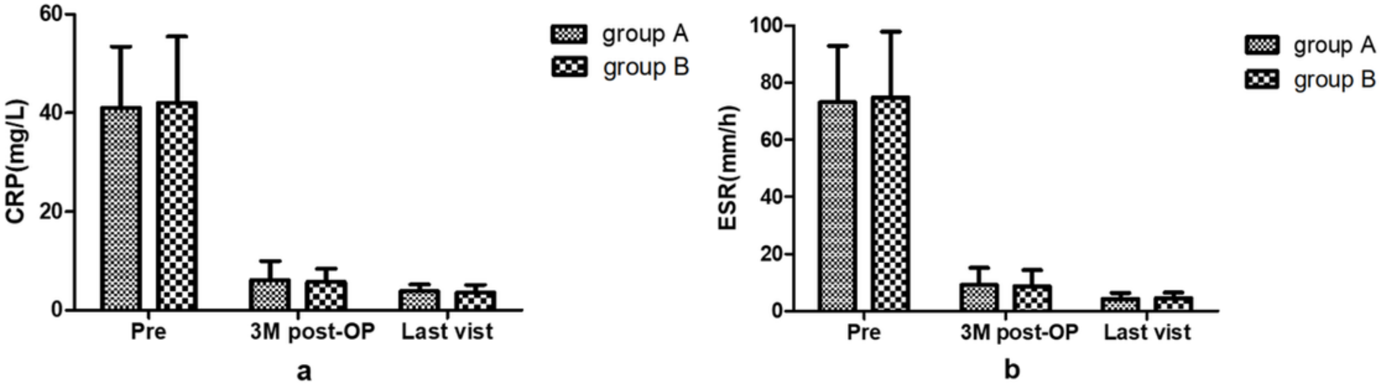

Figure 4

The chart indicated the levels of CRP and ESR at pre-operation, 3-month post-operation and last visit from both groups. In general, CRP and ESR of the two groups were significantly decreased after surgery. (a) The mean CRP of group A at each time point (41.08±13.36, 6.13±3.83, 3.88±1.36) showed no significant difference compared to that in group B (45.23±15.73, 5.73±2.94, 3.18±1.59). (b) The mean ESR of group A at each time point (73.13±19.81, 9.13±5.97, 7.29±2.07) showed no significant difference compared to that in group B (70.88±23.04, 8.72±5.67, 7.48±1.94)