Posterior lumbar interbody fusion (PLIF) in lumbar spine infection: a retrospective study

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Objective The aim of the study is to evaluate the clinical and radiographic outcomes for patients undergoing posterior lumbar interbody fusion in the treatment of lumbar spine infection.

Patients and methods This retrospective study included 16 patients (10 men and six women); their mean age was 55.0 ±8.61 years, presented with lumbar infection treated surgically through posterior approach after failure of conservative treatment. Registration Number:- Ortho-surg._4Med.Research_PED.Def._0000004. All patients underwent clinical assessment, laboratory investigations included erythrocyte sedimentation rate in the first hour, white blood cell and C-reactive protein and radiological evaluation included conventional radiographs, computed tomographic scan, and MRI. Pain and disability scores were collected preoperatively and postoperatively including back and bilateral leg pain visual analog scale (VAS) scores. In 10 patients, the lesion was located in a single level, whereas in six patients two levels were affected. The surgical maneuver included posterior instrumentation, disc space debridement, and grafting. The mean follow-up period was 31.50±4.23 months. All patients agreed to be included in this study.

Results There were no instances of intraoperative complications or delayed complications requiring subsequent interventions. Patients demonstrated statistically significant reductions in the back and leg pain VAS. The average intraoperative time consumed for the whole surgery was 156 min; the average blood loss for this procedure was 812 ml. The mean postoperative hospital stay was 4.6 days. All patients showed improved VAS. Fifteen patients out of 16 have solid fusion with a fusion rate of 93.75±2.5%. The average postoperative kyphosis decreased from 15 to 8.

Conclusion This study demonstrated that single-stage debridement and instrumentation using the posterior approach (posterior lumbar interbody fusion) appears to be a safe approach in treating lumbar spine infections with no infection recurrence. Pain, neurological deficits, and spinal deformity are likely to improve after surgery.

Sci J Al-Azhar Med Fac, Girls 2019 3:252–260

The Scientific Journal of Al-Azhar Medical Faculty, Girls
2019 3:252–260

Keywords: lumbar spine infection, posterior lumbar interbody fusion, pyogenic infection

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Received 13 February 2019 **Accepted** 1 March 2019

Introduction

Spinal infection is an ancient entity with some descriptions dating from the Iron age [1]. In 1779, Pott made the first detailed description of tuberculosis infection in the spine, and a century later, Lanneloung, in France, reported for the first time the term pyogenic osteomyelitis of the spine in medical literature [2].

The key principles for successful treatment of spinal infections are antibiotic therapy for eradication of the underlying infection; fixation of the affected segment to preserve or restore the spinal structure and stability; and debridement and decompression of the spinal canal in the presence of neurological deficits or epidural abscesses [3].

Early surgical treatment should be performed in the presence of neurological deficits or sepsis [4]. Absolute surgical indications also include spinal instability due to extensive bone destruction, severe kyphosis, intracanal spinal lesion with mass effect, unknown etiologies associated with active tumor, and failure of conservative treatment [3].

Some authors also recommend surgical treatment in the presence of epidural abscess even without associated neurological deficits, especially in the cervical and thoracic region [5]. The relative indications consist of the presence of uncontrolled pain and inexistent conditions for conservative treatment [6].

Despite indication for surgery in the presence of neurological deficits, age and presence of concurrent medical conditions may affect surgical decision [7]. According to Yoshimoto *et al.* [8], in a review of 45 cases of pyogenic spondylitis in the elderly, 42% of patients with paralysis on admission were not submitted to surgery due to poor general condition. Yet, paralysis was improved in 73% of these patients with conservative treatment [8].

The main goals of surgical treatment of spinal infections include (i) early decompression of the spinal canal and stabilization of the involved

vertebral segment, in the presence of neurological deficits [9]; (ii) aggressive tissue debridement, including drainage of paravertebral abscesses; and (iii) sample harvesting for microbiological and histological analyses.

At the thoracolumbar juncture, decompression and stabilization are recommended in the presence of a neurological deficit or extensive epidural invasion. In cases of monosegmental spondylodiscitis with moderate anterior bone involvement and minimal kyphosis deformity, a posterior lumbar interbody fusion (PLIF) may be sufficient [10].

Classically, bone grafting with tricortical iliac autograft is recognized as a safe procedure, with excellent and consistent outcomes [11].

PLIF is a type of interbody fusion technique used in lumbar fusion surgery. It is one of the several possible interbody fusion techniques in the lumbar spine.

PLIF technique was first described more than 60 years ago by Cloward, who reported overall excellent results with more than 85% success rate achieving fusion and pain control in a series of 321 patients [12].

Standard fusion alternatives to PLIF include anterior lumbar interbody fusion, transforaminal interbody fusion, and lateral interbody fusion (extreme lateral interbody fusion or direct lateral interbody fusion).

Indications for one interbody technique over another still have yet to be completely elucidated from the available evidence in the literature. In fact, the necessity of using an interbody fusion technique over posterolateral fusion alone has yet to be completely validated in the literature [13].

The aim of this study is to present cases of lumbar spine infection treated through the posterior approach to evaluate the possibility and feasibility of the use of this single approach as less invasive alternative treatment.

Patients and methods

Between February 2016 and August 2018, 16 patients presented with lumbar spine infection at Al-Hussein University Hospital, those who did not respond to conservative treatment had been surgically treated through single posterior approach. Six patients were women, whereas 10 patients were men. The mean age was 55.0±8.61 years with range between 43 and 70 years. The follow-up period ranged between 24 and 36 months with a mean follow-up period of 31.50±4.23 months (Table 1).

Table 1 Descriptive of the studied cases according to different parameters (*n*=16)

	Minimum–maximum	Mean±SD
Age (years)	43.0–70.0	55.0±8.61
The follow-up period	24.0–36.0	31.50±4.23

Table 2 Descriptive of the studied cases according to the level (*n*=16)

Level	*n* (%)
L3/L4	6 (37.5)
L4/L5	2 (12.5)
L5/S1	2 (12.5)
L4/L5 and L5/S1	4 (25.0)
L3/L4 and L4/L5	2 (12.5)

The selection criteria including those patients with failed conservative treatment or those presented from the start either with neurological deficits and or abscess. Ideal candidates are those with limited vertebral body destruction, single-segment involvement, epidural abscess in the posterior dura, and spinal stenosis.

Before the operation, the patients were questioned as regards the duration of symptoms with special attention paid to back pain, paresthesia, and history of prior surgery. The history of previous discectomy was present in two cases, whereas urological intervention was well known in other two patients before the development of back pain In 14 patients there was no history of previous surgical interference.

All patients before the operation underwent MRI in the T1 sequence with and without contrast, T2 and short inversion time inversion recovery, computed tomography and a standard radiograph. This was to evaluate the extent of the infection, the possible compression of nerve structures, and the degree of bone erosion and kyphosis.

In 10 patients single level was affected (L3/L4 six patients, L4/L5 two patients, and L5/S1 in two patients); in six patients two levels were affected (Table 2).

In four patients the abscess was epidural, eight patients were anterior, and in four patients it was both (Table 3 and Figs 1 and 2).

All patients submitted to a neurological examination and laboratory exams included complete blood cell count with differential, erythrocyte sedimentation

Table 3 Descriptive of the studied cases according to the abscess (*n*=16)

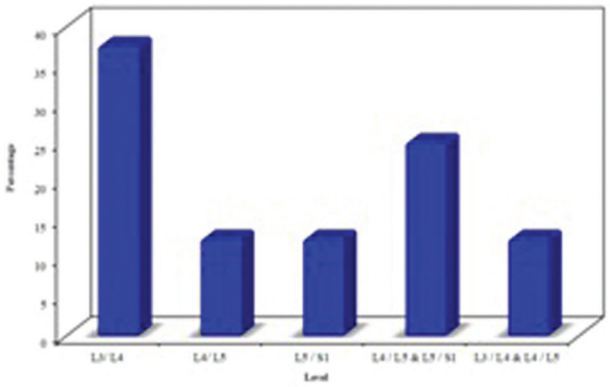
Abscess	*n* (%)
Epidural	4 (25.0)
Anterior	8 (50.0)
Both	4 (25.0)

Table 4 Descriptive of the studied cases according to preoperative data (laboratory data) (*n*=16)

Laboratory data	Minimum–maximum	Mean±SD	Median
CRP level	24.0–96.0	56.25±27.85	52.0
ESR (mm/h)	70.0–120.0	86.88±14.45	82.50

CRP, C-reactive protein; ESR, erythrocyte sedimentation rate.

Figure 1



Descriptive of the studied cases according to the level (*n*=16).

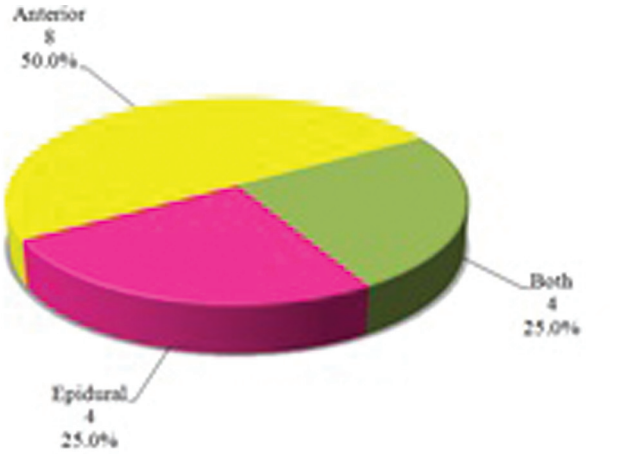
rate (ESR), and C-reactive protein evaluation (Table 4). The ESR was elevated in all patients with range between 70 and 120 mm/h with main ESR of 97.6 mm/h.

Surgical technique

Under general anesthesia in prone position, surgery was performed through single midline posterior spinal incision centered over the affected segments. After blunt retraction of paravertebral muscles, transpedicular screws were applied into the adjacent segment. Preoperative radiological assessment of vertebral destruction as well as intraoperative assessment can determine the possibility of insertion of screws in the affected vertebra.

After insertion of pedicle screws, interlaminar decompression is done with special care to avoid root and dura injuries. Through retraction of the dura and nerve roots, the affected disc could be exposed. The epidural abscess was then evacuated (Fig. 3). After exploration of the affected disc, the evacuation and debridement can be achieved. The debridement was completed through curettage of both end plates up to normal cancellous bone.

Figure 2



Descriptive of the studied cases according to abscess (*n*=16).

The autogenous cancellous iliac bone grafts were then added to fill the intervertebral space and to reconstruct the anterior column. Wound closure with drain was done in a usual pattern. In our series no interbody metal or polyetheretherketone cage was inserted. In no case total corpectomy was necessary.

Intraoperative smears and tissue samples were taken for histological and microbiological assessment. Antibiotics were administered intravenously for 2–3 weeks. When inflammatory marker levels declined to normal values, oral antibiotics were given for a further 12 weeks.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package, version 20.0 (IBM Corp., Armonk, New York, USA). Qualitative data were described using number and percentage. The Kolmogorov–Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, SD, and median. Significance of the obtained results was judged at the 5% level.

Wilcoxon signed-rank test was used for abnormally distributed quantitative variables, to compare between two periods.

Results

The intraoperative as well as postoperative data were recorded. No major intraoperative complications either neurological or vascular injuries were reported.

Postoperative infection

No deep infection was detected, whereas superficial infection occurred in one patient that required surgical debridement with complete resolution.

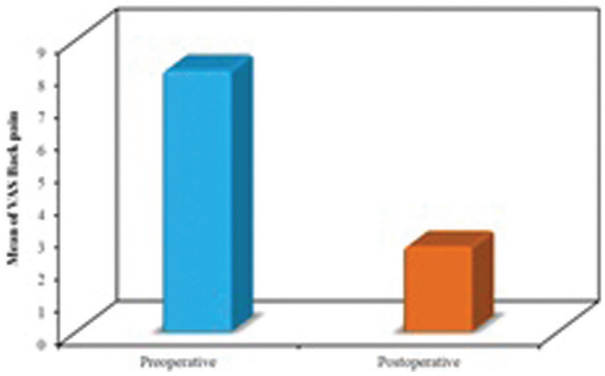
The patients were assessed preoperatively and postoperatively using the visual analog scale (VAS) score for back and leg pain and were compared. The preoperative VAS for back pain ranged between 9 and 7 with a mean VAS score of 8. The VAS score for leg pain ranged between 3 and 7 with a mean VAS score of 5.1. The mean postoperative VAS score for back pain is 2.5 with range between 2 and 4, at the end of follow-up. The mean VAS score for leg pain is 2 with range between 1 and 3, at the end of follow-up (Tables 5 and 6, Figs 4 and 5).

At the end of follow-up, 15 cases showed solid fusion with a rate of 93.75±2.5% (Figs 6–8). In one case, the fusion was questionable without clinical symptoms that indicate further surgery.

The postoperative local kyphotic deformity improved from 15° to 8° (Table 7)

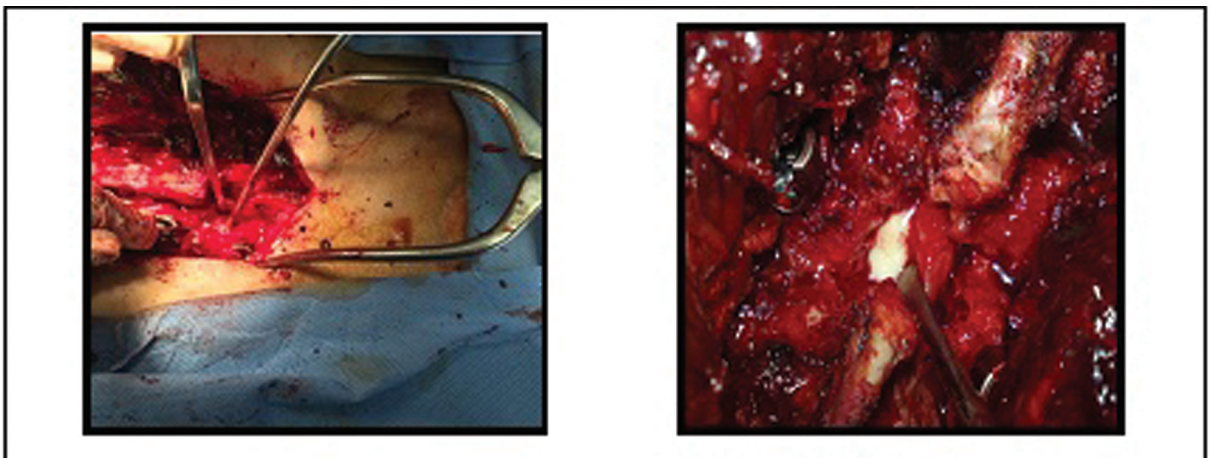
The duration consumed for whole surgery including harvesting of iliac bone graft ranged between 130 and 190 min with main duration of 156.8 min. The blood

Figure 4



Comparison between preoperative and postoperative visual analog scale (VAS) for back pain (*n*=16).

Figure 3



Drainage and evacuation of local epidural abscess.

Table 5 Comparison between preoperative and postoperative visual analog scale score for back pain (*n*=16)

Visual analog scale score	Preoperative	Postoperative	*Z*	*P*
Leg pain				
Minimum–maximum	3.0–7.0	1.0–3.0	3.556*	<0.001*
Mean±SD	5.13±1.02	1.81±0.66		
Median	5.0	2.0		

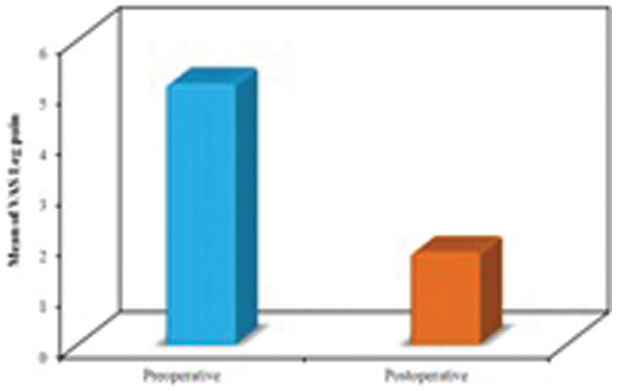
Z, Wilcoxon signed-rank test. *$P \leq 0.05$, statistically significant.

Table 6 Comparison between preoperative and postoperative visual analog scale score (*n*=16)

Visual analog scale score	Preoperative	Postoperative	*Z*	*P*
Back pain				
Minimum–maximum	7.0–9.0	1.0–4.0	3.544*	<0.001*
Mean±SD	8.06±0.77	2.63±1.02		
Median	8.0	2.50		

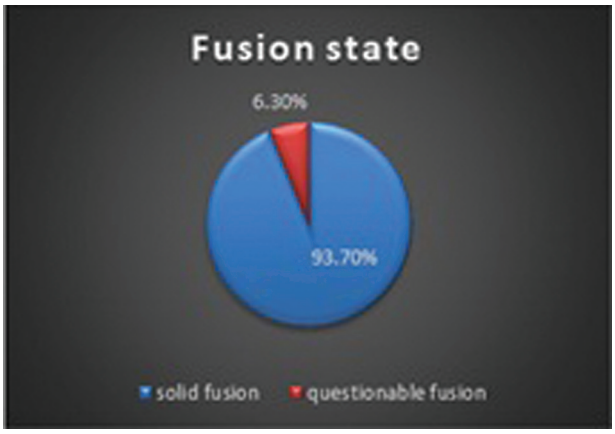
Z, Wilcoxon signed-rank test. *$P \leq 0.05$, statistically significant.

Figure 5



Comparison between preoperative and postoperative visual analog scale (VAS) for leg pain (*n*=16).

Figure 6



Postoperative fusion state.

loss ranged between 500 and 1300 ml with mean intraoperative blood loss of 812 ml (Table 8).

Discussion

With recent literature indicating a rise in the incidence of both discitis and osteomyelitis [14], spine surgeons will be called on with increasing frequency to assess these patients for possible surgical intervention. Patients with primary active infections elsewhere, most commonly bacteremia, are at the highest risk of developing discitis and osteomyelitis, followed by those with infections of the upper respiratory tract and urinary tract. Other commonly affected populations include patients who are diabetic, immunocompromised, undergoing dialysis, and intravenous drug users [4,14–17].

Although the standard treatment for osteomyelitis entails a lengthy course of intravenous antibiotics followed by oral antibiotics, there are strong indications for surgical intervention, including the failure of medical therapy, neurological deficit, progressive deformity, and intractable pain [15,18,19].

Surgical treatment of lumbar spine infection presents multiple challenges because of the significant comorbidities that are common in this patient population [20]. We present a series of patients with lumbar spine infection who were surgically treated with a PLIF for eradication of infection.

The complications of spinal infection, including spinal epidural abscess, neurologic deficits, and mechanical spinal instability usually require surgical intervention [21].

Despite the belief of many surgeons, the use of metallic implants has recently become more common. A combination of radical debridement and instrumentation has benefits such as stabilization of the spine and shortening the postoperative bed rest period [22].

Treatment typically involves surgical drainage and spinal cord decompression together with long-term systemic antibiotics, and many retrospective studies support this approach as the treatment of choice. There is some strong support for urgent surgical decompression and commencement of antibiotic therapy [23].

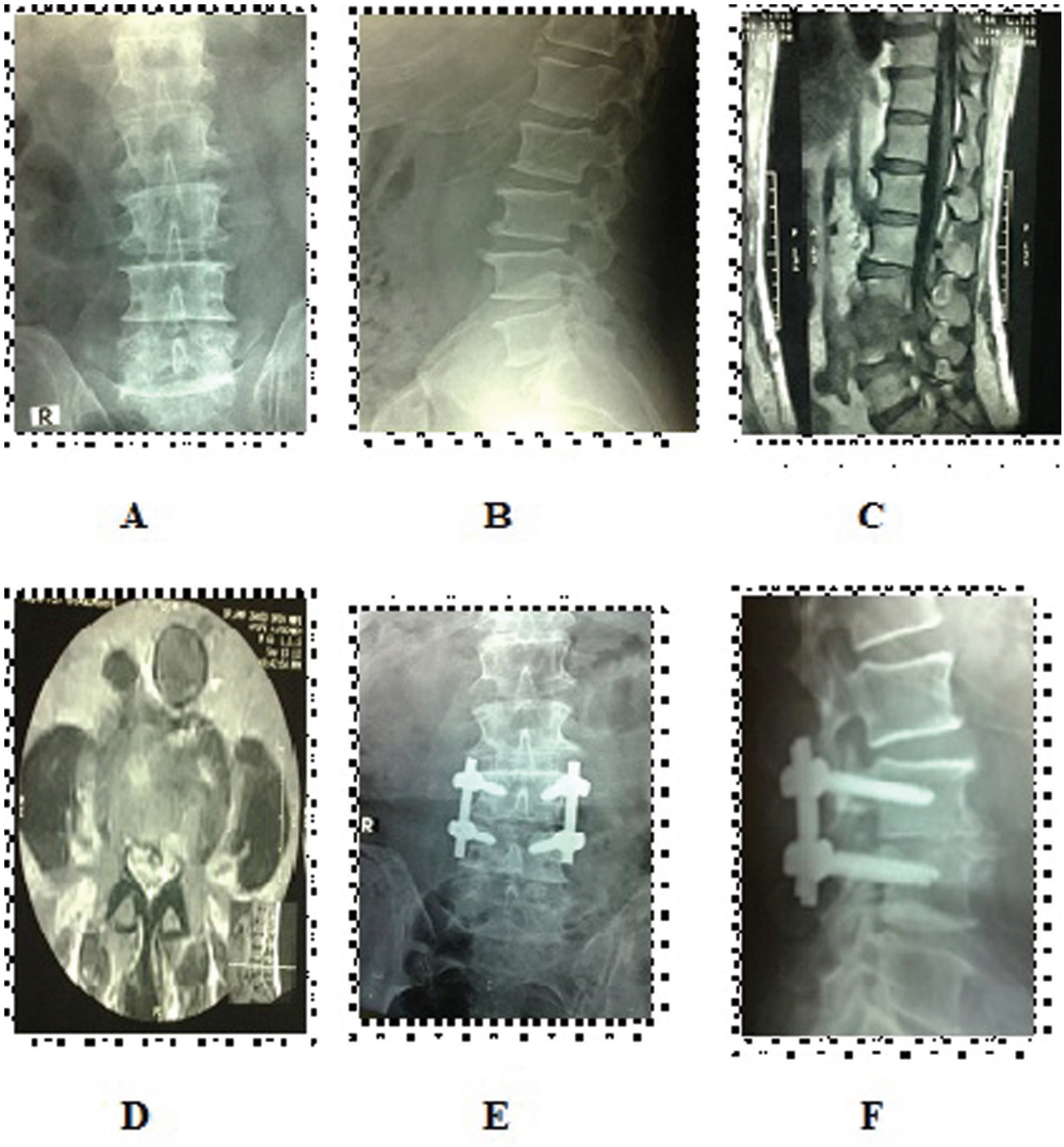
Most surgical approaches to the spine were originally developed to treat spinal tuberculosis. In the 1920s, Hibbs and Albee developed the distant operation of posterior spinal fusion for the treatment of Pott's disease [24].

The decision to progress to fusion in our series was made by the treating surgeon. This was based on the patient exhibiting predicted instability after debridement. Although formal instability was not documented for each patient, predicted instability was assessed by the treating surgeon on initial computed tomographic scan or MRI after looking at the amount of vertebral body destruction.

Posterior approach is convenient for draining of abscesses and instrumentation of posterior implants. Sometimes a combined approach may be required depending on the surgical goal that the surgeons want to accomplish [25].

Single posterior approach has few important advantages over most standard approaches compared with anterior rout; one can avoid entering thoracic and/or abdominal cavity with less morbidity for the patient, decreased operating time and blood

Figure 7



A 66-year-old-man with spinal infection at L3–L4. (a, b) Radiographs showed loss of vertebral endplate definition and reduction of disc height at the level of L3/L4 vertebrae. (c, d) MRI showed decreased vertebral endplate signal intensity on T1-MRI; posterior lumbar interbody fusion surgery was done for him with follow-up. (e, f) Postoperative radiography showed definite fixation for the affected segment.

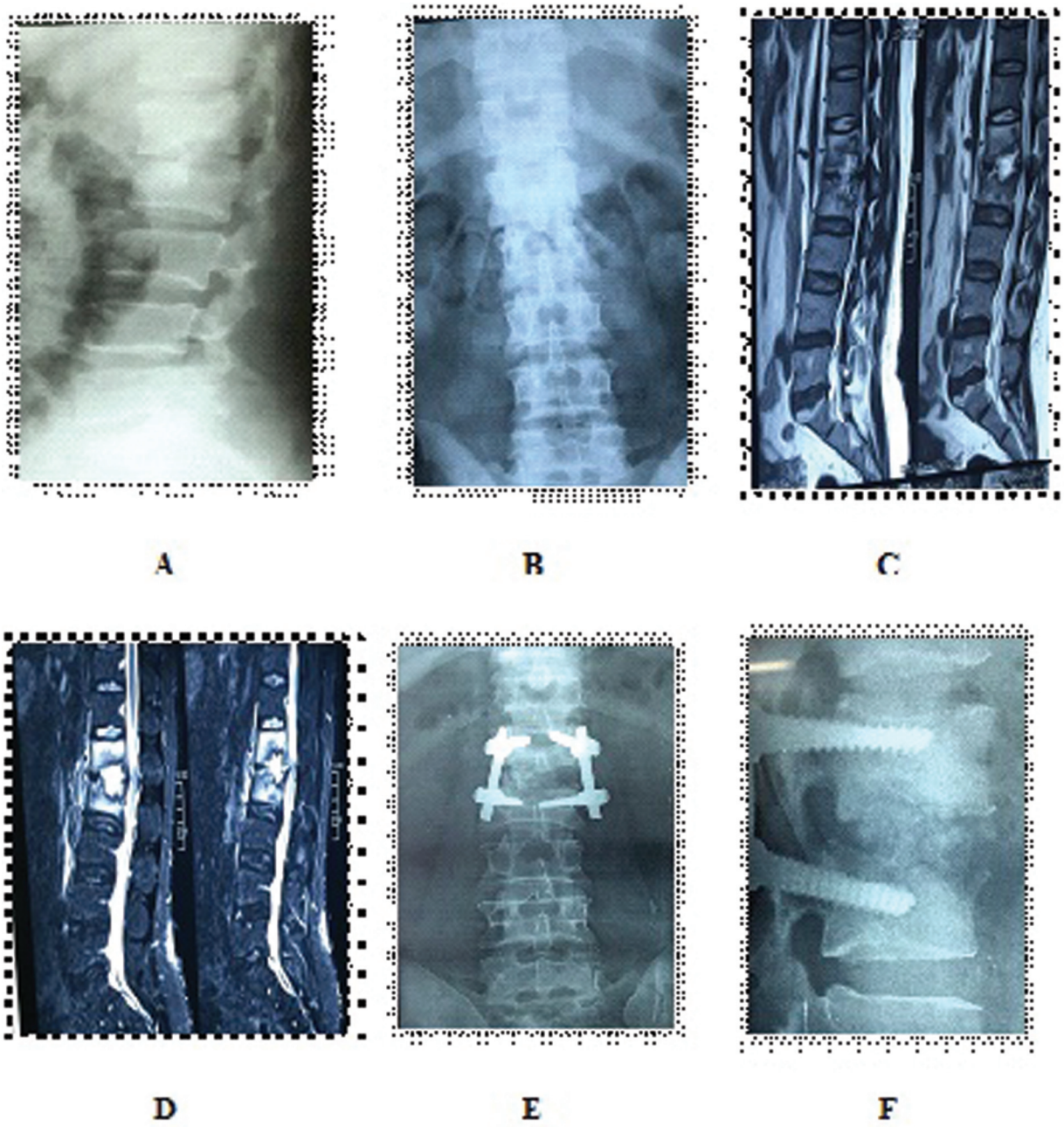
loss, as well as decreased hospitalization and rehabilitation [26].

The greatest advantage of PLIF is that it dynamically decompresses neural structures by holding the vertebral bodies apart and fusing them into a single motion segment [27].

Si *et al.* [28] ?compared anterior and posterior single-stage operations and reported satisfactory deformity correction, suggesting that single-stage operations via either approach are adequate for spinal stabilization.

In the last decade, there have been numerous studies challenging this long-held belief. Ours is one such study adding to the body of evidence including recent publications by Gorensek *et al.* [22],Wang *et al.* [29], Masuda *et al.* [30], Lu *et al.* [31], and Gonzalvo *et al.* [32]. All of these studies have shown that instrumentation can be carried out at the time of surgical debridement when coupled with antibiotic therapy.

Figure 8



A 41-year-old man with L1–L2 spinal infection. (a, b) A plain radiograph showed reduced height of disc space, without any findings of spinal infection. (b, c) T1–T2 MRIs show increased signal changes of L1/L2 disc with epidural and abscess. (e, f) A plain postoperative radiograph showed definite fixation of the affected segment and bone grafting.

Table 7 Descriptive of the studied cases according to different parameters (*n*=16)

	Minimum–maximum	Mean ±SD	Median
The postoperative local kyphotic deformity	8.0–15.0	11.0 ±2.07	11.0

The Gorensek *et al.* [22] series reported no instances of infection recurrence and solid bony fusion was achieved in 15 (88%) of 17 patients.

Wang *et al.* [29] reported no hardware failure and no patients showed any signs of reinfection.

Masuda *et al.* [30] performed a two-staged procedure where a posterior incision was made first and pedicle screw–rod complex inserted, and then anterior debridement and fusion was carried out. Two patients had postoperative superficial wound complications but these did not require reoperation [30].

Lu *et al.* [31] reported two instances of infection recurrence in their 36 patient series (5.5%), one due to noncompliance with tuberculosis medication and the other was a diabetic man who had the resulting

Table 8 Descriptive of the studied cases according to different parameters (*n*=16)

Number of cases	Age (years)	Sex		Operation time (min)	Blood loss (ml)	Hospital stay (days)	Follow-up (months)
		Male	Female				
16	55.0±8.61	10	6	156.88±18.15	812.50±248.66	4.69±1.49	31.50±4.23

collection drained under radiographic guidance. There were no instances of implant failure.

Gonzalvo *et al.* [32] reported that all patients had complete infection resolution, reduction of pain, and improvement in neurological function.

Currently, Pott's disease is managed in a similar fashion as pyogenic spinal infections. During the last 20 years, there have been few reports of operative treatment for spinal tuberculosis where the authors have used instrumentation [33].

This study are consistent with our results which showed no deep infection recurrence in all patients, whereas superficial infection occurred in one patient that required surgical debridement with complete resolution, improvement in neurological function, and a significant reduction in pain as measured by the VAS.Regarding the fusion rate in our study at the end of follow-up, 15 cases showed a solid fusion with a rate of 93.7%. In one case, the fusion was questionable without clinical symptoms that indicate further surgery. The postoperative local kyphotic deformity improved from 15° to 8°.

The time consumed for surgery in our series as well as the blood loss is substantially lower when compared with combined anteroposterior approaches whatever be the stage.

Fukuta *et al.* [34] reported 427 min for the two-stage combined anteroposterior approach, whereas Safran *et al.* reported 345 min for the single-stage anteroposterior approach, as opposed to a mean duration of 156.8 min in our series.

Blood loss was also lower compared with other studies. Combined single-staged procedure was reported to have a blood loss of 1700 ml and double-staged combined approach of 2700 ml [22] as opposed to 812 ml in our series.

After years of experience with PLIF, the authors recommend a technique that enhances a high rate of fusion by utilizing the following four biomechanical principles [35]:

(1) Preservation of the integrity of the posterior portion of the motion segment.
(2) Partial preservation of the integrity of the cortical endplates.
(3) Attempted maximal removal of the disc material.
(4) One-piece grafts, as applied to PLIF, a 'unigraft' concept, to fill all the disc space compactly with autogenous bone grafts.

Limitations and recommendations

The retrospective nature and the small patient population limits the study. Future prospective study should further define the long-term outcomes of this approach.

Conclusion

This study demonstrated that single-stage debridement and instrumentation using the posterior approach (PLIF) appears to be a safe approach in treating lumbar spine infections with no infection recurrence.

Pain, neurological deficits, and spinal deformity are likely to improve after surgery.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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