Transforaminal lumbar interbody fusion in recurrent disc herniation

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Background
Recurrent back and/or leg pain after primary lumbar discectomy is not uncommon. Some spine surgeons believe that fusion is necessary for treating disc reherniation. As repeated discectomy requires the removal of more disc material and posterior elements, such as lamina or facet joint, further invasion at the same surgical level can increase the risk of segmental instability.

Patients and methods
A total of 20 patients (12 men, eight women) with recurrent lumbar disc herniation were treated via transforaminal lumber interbody fusion. The mean age at the time of operation was 46.6 years (30–62 years). The primary procedures included discectomy with unilateral hemilaminectomy in nine and discectomy with bilateral laminectomy in 11 patients. The time from the primary surgery to that of recurrence averaged 10.6 months (range, 6–18 months). The levels of recurrent disc herniation were nine cases at L4–L5 (six ipsilateral and three contralateral) and 11 at L5–S1 (seven ipsilateral and four contralateral).

Results
The mean follow-up period was 22.8 months (18–30 months). The mean duration of the operation was 161.75 min (130–190–min), mean intraoperative blood loss was 325 ml (250–500), and mean duration of hospital stay was 4.15 days (3–7 days). At a minimum of 12 months of follow-up, all cases appeared to have solid fusions.

Conclusion
Transforaminal lumbar interbody fusion technique is an effective procedure with satisfactory clinical results for the treatment of recurrent lumbar disc herniation. The approach achieves a biomechanically stable spine, as it restores the segmental lordosis and has low complication rates.

Keywords:
interbody, lumbar fusion, recurrent disc, transforaminal lumbar interbody fusion

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Introduction

Recurrent back and/or leg pain after lumbar discectomy is not uncommon. Lumbar laminectomy has a high failure rate, with an incidence of recurrent back pain as high as 47% [1,2], whereas this incidence is 13–28% after discectomy [3,4]. Predisposing factors that correlate with recurrent symptoms and poor outcome are a history of smoking, age more than 40 years, and patients in receipt of workers' compensation [5]. Early recurrence may be owing to reherniation, infection, or arachnoiditis, and later recurrence may be owing to foraminal stenosis, epidural fibrosis, iatrogenic segmental instability, and progressive facet degeneration [6,7].

Recurrent lumbar disc herniation is a major cause of surgical failure; the incidence of which is reported from 5 to 11%, with an increased incidence as the follow-up period is extended [8]. The optimal technique for treating recurrent lumbar disc herniation is controversial. Some believe that repeat discectomy is the treatment of choice, with similar clinical results compared with the primary procedure [9], but approach-related complications can be considerable. Scar tissue makes a repeated discectomy more difficult, increasing the risk of dural tear or nerve injury [10,11]. Other spine surgeons believe that fusion is necessary for treating disc reherniation. As repeated discectomy for either ipsilateral or contralateral recurrence requires the removal of more disc material and posterior elements, such as lamina or facet joint, further invasion at the same surgical level can increase the risk of segmental instability [10,12]. Iida *et al.* [13] reported 46 patients who had underdone either partial or wide laminectomy and were followed up for more than 1 year after surgery. The total number of cases of instability confirmed at the operated level or at both the operated and adjacent levels was 52.2% (24/46). A large retrospective follow-up study of patients undergoing multiple revisions after lumbar discectomy revealed markedly reduced risk for subsequent operations if the first procedure was a spinal fusion (5.0 vs. 24.9% after discectomy and 27.2% after spinal decompression) [14]. Therefore, the use of fusion to treat or prevent segmental instability after repeated discectomy appears to be a reasonable choice in cases of recurrent disc herniation.

The results of posterolateral fusion (PLF) for recurrent lumbar disc herniation [15] were reported, but interbody lumbar fusion techniques have been reported to have higher fusion rates than PLF techniques [16].

Transforaminal lumber interbody fusion (TLIF) technique achieves stable three-column fixation with anterior support, simultaneous anterior and posterior fusion, and inherent stability through a single posterior surgical approach and unilateral placement of interbody cage.

The purpose of this study is to evaluate the efficacy of the TLIF technique for patients with recurrent lumbar disc herniation.

Patients and methods

Between January 2011 and December 2012, 20 patients underwent TLIF for recurrent symptoms after a primary lumbar discectomy at Zagazig University Hospitals. This study was approved by ethical committee of Zagazig University. All patients signed an informative consent form. The study included all patients with recurrent low back and/or leg pain after a single-level discectomy with at least 6 months of pain relief after primary disc surgery and who failed to respond to conservative treatment for at least 6-month duration. Patients with a previous history of infection or malignancy at the affected segment were excluded from the study. Conservative treatment consisted of analgesics, NSAIDs, muscle relaxants, physiotherapy, and epidural or facet joint steroid injections.

All patients had recurrent disc herniation at the same level as previous discectomy, either the ipsilateral or the contralateral side. The primary procedures included discectomy with unilateral hemilaminectomy in nine patients and discectomy with bilateral laminectomy in 11 patients. The time from the primary surgery to that of recurrence averaged 10.6 months (range: 6–18 months).

The levels of recurrent disc herniation were nine cases at L4–L5 (six ipsilateral and three contralateral) and 11 at L5–S1 (seven ipsilateral and four contralateral).

Table 1 Demographic and complaint characteristics of the studied cases

Studied group (*N*=20)	
Age [mean (SD)]	46.6 (11.06)
Sex [*n* (%)]	
Male	12 (60)
Female	8 (40)
The primary procedure [*n* (%)]	
Discectomy with hemilaminectomy	9 (45)
Discectomy with bilateral laminectomy	11 (55)
The level of disc herniation [*n* (%)]	
L4/L5 level	9 (45)
L5/S1 level	11 (55)
Occupation [*n* (%)]	
Worker	3 (15)
Farmer	4 (20)
Housewife	9 (45)
Teacher	3 (15)
Retired	1 (5)

The study group consisted of 20 patients (12 men, eight women) whose mean age at the time of operation was 46.6 years (30–62 years). The mean follow-up was 22.8 months (18–30 months). Eight (40%) patients had undergone discectomy on two previous occasions and the rest (*n*=12, 60%) had one previous operation before admission to hospital (Table 1). Each patient underwent a detailed clinical examination and preoperative radiological assessment, including plain radiographs with dynamic films and gadolinium-enhanced MRI scans.

Surgical techniques

Once the diagnosis had been confirmed, all patients underwent TLIF at the symptomatic level. Bilateral dissection was extended just lateral to the facet joints through a midline posterior approach. The epidural scar tissue in the area of the previous laminectomy was left intact. Pedicle screws were inserted under direct vision before undertaking the decompression. On the symptomatic side, the pars interarticularis was removed and a hemifacetectomy performed on the superior and inferior facets at the level of the spinal segment to be fused. These cuts provide access to the intervertebral disc. The traversing nerve root is protected by sliding a retractor along the upper surface of the pedicle of the inferior vertebra. The exiting nerve root hugs the inferomedial surface of the pedicle and can be directly visualized throughout the procedure. A nearly complete discectomy is performed using disc shavers, curettes, and rongeurs. End-plate decortication was performed. Preserving the end plate is crucial to a successful outcome, as is the placement of the cage in the lateral part of the disc, where the end plates are thickest. This step is essential in revision surgery, as it reduces the need to interfere with the midline scar tissue, minimizing the risk of damage to dura and nerve roots.

Intervertebral disc space spreaders were then sequentially inserted and rotated to restore the normal disc space height (DSH). Once the disc space was distracted, the anterior two-thirds of the disc space was packed with cancellous bone from the laminectomy bone and autogenous graft from the iliac crest. A single Poly ether ether ketone (PEEK) cage packed with bone graft was inserted posterolaterally and oriented anteromedially. A lateral fluoroscopic image was obtained to confirm proper positioning of the PEEK cage. Then, connecting rods were placed, and compression was applied across the instrumentation to restore segmental lordosis (SL) and the rods were locked in place.

Clinical and radiographic evaluation

The patients were examined, and data were recorded preoperatively and postoperatively at 3, 6, 12, and at the latest follow-up. The clinical symptoms were assessed at each interval. All patients underwent preoperative and postoperative evaluation of pain and functional status using self-administered questionnaires. The intensity of back and leg pain was measured using visual analog scale (VAS), and functional outcome was assessed using the Oswestry Disability Index (ODI) [17].

The radiographs of all patients were evaluated with particular focus on the fusion status, SL, and DSH at the fused segment. An independent observer made radiographic assessments. Anterior-posterior and lateral radiographs were done at each follow-up visit. DSH and SL were used as parameters reflecting sagittal alignment on plain radiographs. The DSH was determined to be the distance from the midpoint of the anteroposterior diameter of the inferior end plate to the superior end plate [18]. The SL at L4–L5 was defined as the angle subtended by the superior end plate line of L4 and the inferior end plate line of L5. The SL at L5–S1 was defined as the angle subtended by the superior end plate line of L5 and the superior end plate line of S1 [19].

Flexion and extension radiograph were done at 12, and at the latest follow-up. Criteria for a successful fusion were the lack of motion, anterior bridging bone, and the lack of lucencies on flexion/extension radiograph and/or contiguous bone through the cage using a thin-cut sagittal computed tomographic scan. However, in a few questionable cases, computed tomographic scans were obtained to confirm fusion (*n*=5, 25%).

Results

The 20 patients in the study group had a single-level fusion; the commonest levels addressed were L4/L5 and L5/S1. The L5/S1 (*n*=11) was the most frequently fused level. The mean duration of the operation was 161.75 min (130–190 min), mean intraoperative blood loss was 325 ml (250–500 ml), and mean duration of hospital stay was 4.15 days (3–7 days) (Table 2). All cases were followed up for a mean of 22.8 months (18–30 months) postoperatively.

Clinical outcomes

The mean ODI score was 56.85 (32–82) preoperatively which had improved to 21.6 (6–34) at 6 months postoperative and had further improved to 11.65 (6–20) at final follow-up ($P<0.001$). The mean VAS for back pain score was 65.6 (40–80) preoperatively, which had improved to 24.75

Table 2 Operative and postoperative data

Studied group (*N*=20)	
Operation time [mean (SD)] (min)	161.75 (20.27)
Estimated blood loss [mean (SD)] (ml)	325 (80.29)
Hospital stay [mean (SD)] (days)	4.15 (1.13)
Operative and postoperative complication [*n* (%)]	
Dural tear	2 (10)
Wound infection	1 (5)
Persistent pain	3 (15)

Table 3 Mean (SD) of visual analog scale for leg pain, visual analog scale for back pain, and Oswestry Disability Index before surgery, 6 months, and at final follow-up visit

	Studied patients (20 cases)						
	Preoperative		6 months postoperative		Final follow up		
Characteristics	Mean	SD	Mean	SD	Mean	SD	*P* value
VAS for leg pain	73.9	8.66	14.55	7.52	5.65	4.5	<0.001*
VAS for back pain	65.6	11.27	24.75	6.07	12.1	5.4	<0.001*
ODI	56.85	15.1	21.6	7.8	11.65	5.35	<0.001*

*There is a highly statistical significant difference in VAS for leg pain, VAS for back pain, and ODI before surgery, 6 months, and at final follow-up visit (paired *t* test was used). ODI, Oswestry Disability Index; VAS, visual analog scale.

(15–37) at 6 months postoperative and had further improved to 12.1 (1–25) at final follow-up ($P<0.001$). Leg pain decreased rapidly within 1 month in all patients and continued to decrease at the time of the latest follow-up. The mean VAS for leg pain was 73.9 (60–90) preoperatively and 14.55 (1–30) at 6 months postoperative and had further improved to 5.65 (0–15) at final follow-up ($P<0.001$) (Table 3).

Complications

Complications occurred in six (30%) patients; two (10%) had a dural tear in association with epidural fibrosis, which occurred during the surgical decompression and were repaired during the operation, and there were no cerebrospinal fluid leaks postoperatively. These patients had no further complications and were discharged from hospital within a week. One (5%) patient had a superficial infection, which resolved with oral antibiotics. Three (15%) patients experienced severe leg pain during the early postoperative period, which completely resolved within 3 months (Table 2). There were no major complications, permanent neurological

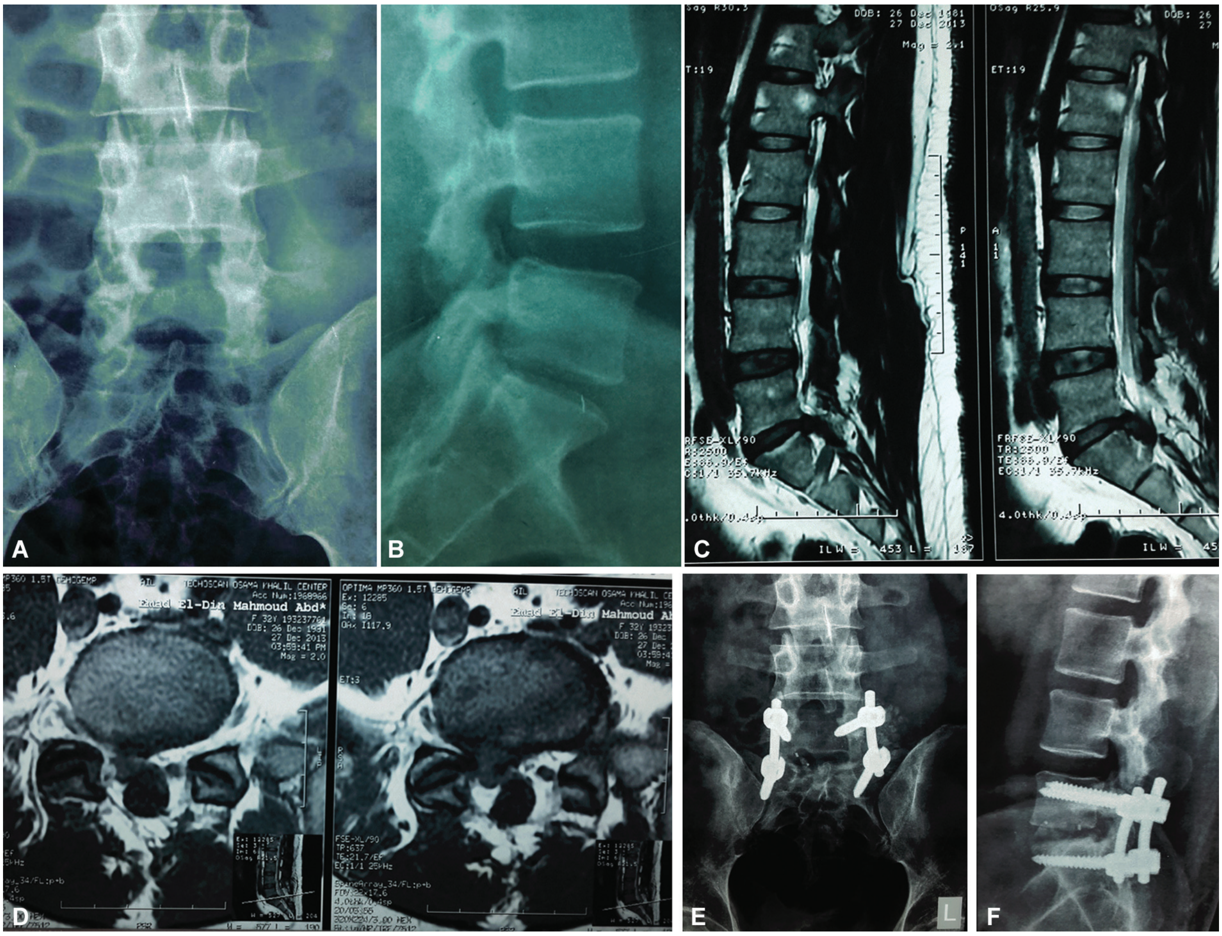
Table 4 Mean (SD) of disc space height before and after surgery

	Studied patients (20 cases)				
	Preoperative		Postoperative		
Characteristics	Mean	SD	Mean	SD	*P* value
Disc space height (mm)	11.55	2.354	23.65	2.9	<0.001

Table 5 Mean (SD) of segmental lumbar lordosis before and after surgery at L4/L5 and L5/S1 levels

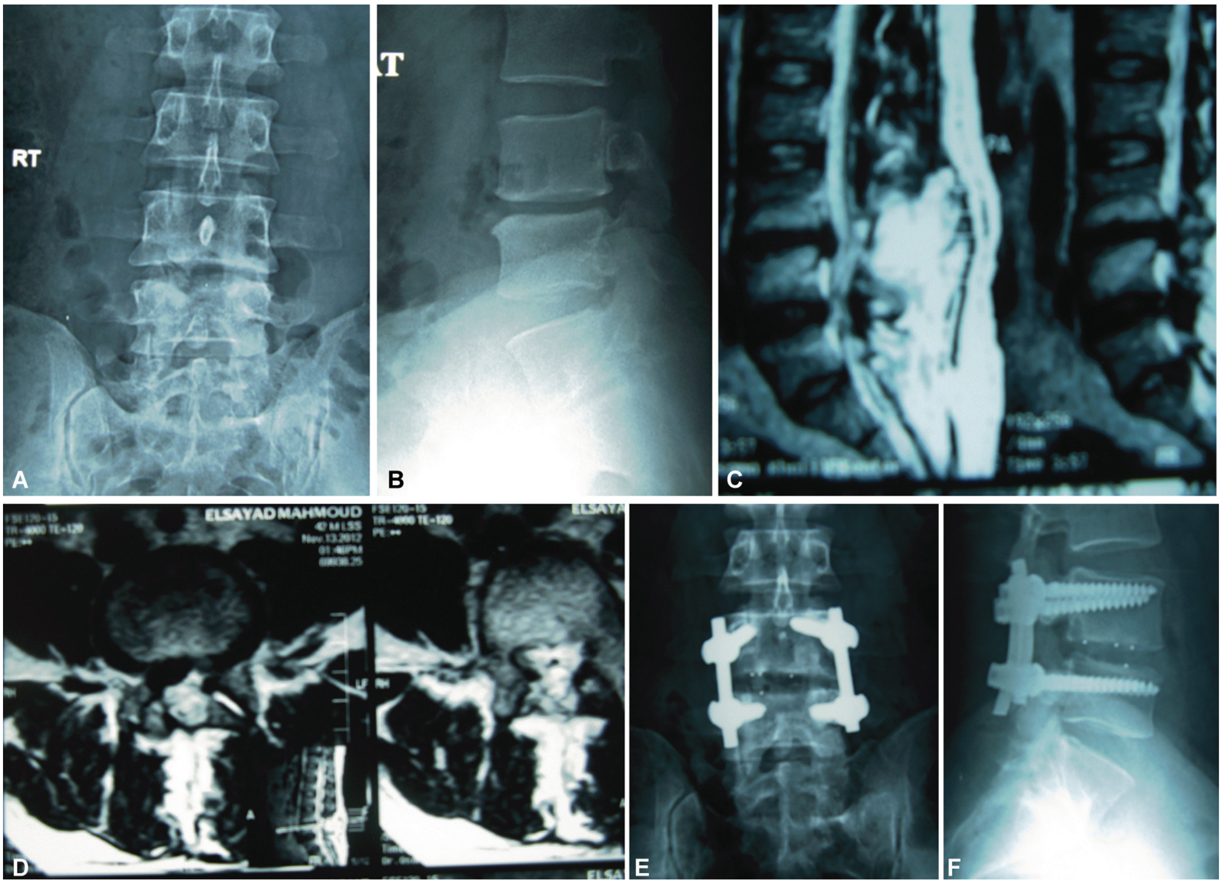
	Studied patients (20 cases)				
	Preoperative		Postoperative		
Characteristics	Mean	SD	Mean	SD	*P* value
Segmental lordosis at L5–S1 level (11 patients)	39.27°	2.5	45.63	1.91	<0.001
Segmental lordosis at L4–L5 level (9 patients)	14.44°	1.4	16.55°	1.66	0.476

Figure 1



A 33-year-old male patient with recurrent lumbar disc at L5/S1 level. Preoperative radiograph (a) anteroposterior radiograph, (b) lateral radiograph, (c) sagittal MRI, (d) axial MRI and postoperative radiograph, (e) anteroposterior radiograph, and (f) lateral radiograph.

Figure 2



A 45-year-old male patient with recurrent lumbar disc at L4/L5 level. Preoperative radiograph (a) anteroposterior radiograph, (b) lateral radiograph, (c) sagittal MRI, (d) axial MRI and postoperative radiograph, (e) anteroposterior radiograph, and (f) lateral radiograph.

deficit, pulmonary embolism, perioperative cardiac event or death.

Radiographic results

The DSH measurement, preoperatively and postoperatively, was performed on standardized lateral radiograph views. Disc height was significantly increased after surgery. The mean DSH before surgery was 11.55 ±2.35 mm which increased to 23.65±2.9 mm after TLIF ($P<0.001$) (Table 4). Mean preoperative SL was 39.27 ±2.5° at L5–S1. Lordosis was significantly increased to a mean of 45.63±1.91° at both the first postoperative visit and the latest follow-up visit. At the L4–L5 segment, mean segmental lordotic angle for preoperative (14.62 ±1.4°) and postoperative follow-up (16.75±1.66°) did not change significantly (Table 5). No patient had evidence of implant failure (Figs 1 and 2).

Discussion

Recurrent low back pain after discectomy may be owing to many factors; progressive disc degeneration and fragmentation causing inability to withstand normal mechanical loads, [4] a high concentration of inflammatory mediators in the disc space, spondylolytic changes, and osteophyte formation around the vertebral body [4]. Recurrent leg pain may be owing to referred pain, foraminal stenosis, segmental microinstability [20,21], or epidural fibrosis [1,20,22]. Changes can coexist in patients who have undergone discectomy and require revision surgery when conservative measures have failed. Revision decompression and/or discectomy alone might lead to further disc degeneration, segmental instability, and further symptoms in these patients.

The optimal surgical approach for recurrent disc herniation remains a subject of controversy. Discectomy with fusion has several theoretical advantages. Specifically, interbody fusion reduces or eliminates segmental motion, immobilizes the spine, reduces mechanical stresses across the degenerated disc space [23], and may reduce additional herniation at the affected level [24]. Lehmann and LaRocca [15] treated 36 patients following previous lumbar discectomy by spinal canal decompression and spinal fusion. Solid fusion correlated closely with satisfactory outcomes, and the patients in the fusion group tended to have better outcomes than those with disc excision alone.

Several surgical techniques have been proposed for the management of patients who have recurrent symptoms after lumbar discectomy. Niemeyer *et al.* [25] in a retrospective study reported the clinical and radiological outcomes of 18 patients who had undergone ALIF and nine who had undergone TLIF. At the final follow-up, there was a statistically significant improvement in ODI and VAS pain scores, but only seven (28%) had returned to work. The mean blood loss was 1240 ml (250–1500 ml) and mean operating time was 275 min (120–645 min). Six (22.2%) patients had complications including two who required repair of the common iliac vein, three who developed retrograde ejaculation, and one deep wound infection. They concluded that successful outcome is independent of the surgical approach and correlates well with successful fusion. Skaf *et al.* [26] also demonstrated that a successful instrumented posterolateral lumbar fusion using transpedicular screws and bone grafts can achieve a successful outcome. Among 50 prospective patients who had failed primary surgery, those with instability (n=14) did better with fusion than those with recurrent disc herniation (n=11), inadequate previous surgery (n=8), or failure owing to fibrosis and adhesions (n=17). There was no clear information given about how many patients underwent PLF as a revision operation. However, among their fusion patients, they reported 50% improvement in symptoms among 92% of patients at 1-year follow-up. No data were available for blood loss, operating time, and complications.

In this study, the patients had significant improvements in all outcome measures. The mean ODI score was 56.85 (32–82) preoperatively, which had improved to 21.6 at 6 months postoperatively (6–34) and further improved to 11.65 (6–20) at final follow-up (P<0.001). The mean VAS for back pain score was 65.6 (40–80) preoperatively, which had improved to 24.75 at 6 months postoperatively (15–37) and further improved to 12.1 (1–25) at final follow-up (P<0.001). Leg pain decreased rapidly within 1 month in all patients and continued to decrease at the time of the latest follow-up. The mean VAS for leg pain was 73.9 (60–90) preoperatively and 14.55 at 6 months postoperative (1–30), which had further improved to 5.65 (0–15) at final follow-up (P<0.001). The mean duration of the operation was 190 min (145–190 min), mean intraoperative blood loss was 325 ml (250–500 ml), and mean duration of hospital stay was 4.15 days (3–7 days). The results were comparably better than in previous studies involving standard posterior lumbar interbody fusion (PLIF) and other revision procedures [25,27]. It has been shown that patients often experience leg pain during the early postoperative period after a standard PLIF [28,29]. By contrast, this is rare after TLIF, probably because there has only been minimal retraction of the nerve roots. There were no permanent neurological complications in this study. The net effect of all these factors is the likely explanation for the shorter hospital stay of our patients compared with those of others [27]. Furthermore, the rate of dural tear in this study is well below that quoted in other studies on revision lumbar surgery through a posterior approach [25,27].

Revision spinal surgery is more challenging than primary surgery, owing to the indistinct anatomical planes and perineural scarring. Ebeling *et al.* [30] reported a complication rate of 13% after repeated discectomy, and dural tears and infections were the most common problems. However, TLIF provides an approach through facetectomy to enter unscarred virgin tissue. Therefore, the surgeon can approach the target site safely without demanding dissection of the fibrotic scar tissues, and excessive retraction of scarred nerve root and dura, and the potential risk of dural tear and nerve injury may also be decreased. Only two (10%) cases experienced dural tear during surgery in our study, which is lower than the previous reports [15,31].Postoperative degenerative changes after the conventional discectomy can arise with time. Gradual disc space subsidence and impingement of the superior facet could result in foraminal stenosis. In this study, we found foraminal stenosis in 11 patients, and the average DSH at the recurrent levels was 11.55 ±2.35 mm. The distraction spreaders were sequentially inserted until the desired annular tension was achieved. As the intervertebral DSH increases, so does the neuroforaminal volume. The postoperative mean disc height at the recurrent level was 23.65±2.9 mm. Because the foraminal portion can be exposed in the course of the TLIF approach, adequate foraminal decompression can be easily done. Satisfactory outcomes were obtained in this study. None of the patients had a poor result, although three patients had transient neurological deficits, which were completely resolved within 3 months. These are comparable with the rates of satisfactory clinical results reported by others [8,9,12,24].

We used a single cage inserted diagonally from the symptomatic side. A more lateral entry point compared with PLIF was used, which can reduce dura and nerve root retraction and minimizes the risk of neurological injury. Zhao *et al.* [32] demonstrated that, as only unilateral facetectomy is required for the insertion of a single cage, the stiffness of the construction is significantly superior to the standalone two-cage analog. TLIF cage enables the reconstruction of the anterior column and restores lumbar lordosis. This study revealed a significant increase in lordosis at the L5–S1 segment but not significantly at the L4–L5 segment. The lordosis increase was directly associated with increased DSH. Bone grafting of the available surface area of the disc space is important for successful fusion. Before cage insertion, the prepared laminectomy bone and iliac crest autograft (n=20) was grafted into the prepared disc space and in the cage. Because we used only one cage, there was more space for the bone graft than when two cages were inserted. The placement of additional bone grafts around the single cage may enhance the fusion rate; there were no pseudarthrosis in this study.

Conclusion

Based on these clinical outcomes, as well as the theoretical advantages of TLIF, we found that the TLIF technique to be an effective procedure with satisfactory clinical results for the treatment of recurrent lumbar disc herniation. The approach achieves a biomechanically stable spine, as it restores the SL and has low complication rates. Cages packed with bone graft are placed in a load-bearing position, which promotes interbody fusion, whereas the segmental pedicle screw construct acts as a posterior tension band.

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Conflicts of interest

There are no conflicts of interest.

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