

# Recurrent lumbar disc herniation: A prospective comparative study of three surgical management procedures

Ayman A. El Shazly, Mohammed A. El Wardany, Ahmad M. Morsi<sup>1</sup>

Department of Neurosurgery, <sup>1</sup>Department of Orthopedic, Ain Shams University, Cairo, Egypt

## ABSTRACT

**Context:** The optimal surgical treatment of recurrent lumbar disc herniation is controversial.

**Aim:** To compare prospectively the clinical outcomes of surgical treatment of recurrent lumbar disc herniation by three different methods; discectomy alone, discectomy with transforaminal lumbar interbody fusion (TLIF), and discectomy with posterolateral fusion (PLF), regardless of the postoperative radiological findings.

**Study Design:** This is a prospective, randomized, comparative study.

**Materials and Methods:** This is a prospective, randomized, comparative study on 45 patients with first time recurrent lumbar disc herniation. Patients were evaluated clinically by using the criteria of the Japanese Orthopedic Association's evaluation system for low back pain syndrome (JOA score). The patients were classified into three groups: Group A; patients who had revision discectomy alone, group B; patients who had revision discectomy with TLIF, and group C; patients who had revision discectomy with PLF. The mean follow-up period was 37 ( $\pm 7.85$  STD) months.

**Results:** The mean overall recovery rate was 87.2% ( $\pm 19.26$  STD) and the satisfactory rate was 88.9%. Comparison between the three groups showed no significant difference with regard to the mean total postoperative JOA score, recovery rate, and satisfactory rate. However, the postoperative low back pain was significantly higher in group A than that of group B and C. Two patients in group A required further revision surgery. The incidences of dural tear and postoperative neurological deficit were higher in group A. The intraoperative blood loss and length of operation were significantly less in group A. The total cost of the procedure was significantly different between the three groups, being least in group A and highest in group B. There was no significant difference between the three groups with regard to the length of postoperative hospital stay.

**Conclusion:** Revision discectomy is effective in patients with recurrent lumbar disc herniation. Fusion with revision discectomy improves the postoperative low back pain, decreases the intraoperative risk of dural tear or neural damage and decreases the postoperative incidence of mechanical instability or re-recurrence. TLIF and PLF have comparable results when used with revision discectomy, but PLF has significantly less total cost than TLIF.

**Key words:** Anterior lumbar interbody fusion, posterior lumbar interbody fusion, posterolateral fusion, recurrent lumbar disc herniation, transforaminal lumbar interbody fusion

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### Address for correspondence:

Dr. Ayman A. El Shazly, Assistant Professor of Neurosurgery, Department of Neurosurgery, Ain Shams University, Ramses Extension Road, Abbasia Square, Cairo, Egypt.  
E-mail: shazlyneuro@yahoo.com

## Introduction

Although various factors contribute to the failure of disc surgery, recurrent disc herniation remains the major source of disability.<sup>[1]</sup> Recurrent lumbar disc herniation has been reported in widely varying incidences between 3% and 18% of the patients and depends on the duration of the follow-up.<sup>[2,3]</sup> Recurrent lumbar disc herniation is defined as disc herniation at a previously operated disc level, regardless of ipsilateral or contralateral herniation, in patients who experienced a pain-free interval of at least 6 months after surgery.<sup>[3,4]</sup> Recurrent disc herniation is a significant problem, as scar formation may lead to increased morbidity after

traditional posterior reoperation.<sup>[5]</sup> Furthermore, persistent low back pain or re-recurrent sciatica may develop in some cases after repeated surgery.<sup>[1]</sup> Also, it is important to consider the possibility of iatrogenic instability during surgery on the lumbar spine for the treatment of recurrent disc herniation.<sup>[6]</sup> The optimal surgical technique for treating recurrent lumbar disc herniation is controversial.<sup>[1]</sup> Some authors believe that in the absence of objective evidence of spinal instability, recurrent lumbar disc herniation may be adequately treated by repeated laminectomy and discectomy alone.<sup>[1-3,7-10]</sup> While others believe that various factors contribute to the failure of repeated lumbar disc surgery and discectomy alone without fusion remains the major source of disability.<sup>[6,11]</sup> Fusion with repeated lumbar discectomy can be broadly categorized as posterolateral fusion (PLF) and interbody fusion. Various techniques for interbody fusion have been described, including anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), and transforaminal lumbar interbody fusion (TLIF).

The purpose of this study was to compare prospectively the clinical outcomes of surgical treatment of recurrent lumbar disc herniation by three different methods; discectomy alone, discectomy with TLIF, and discectomy with PLF, regardless of the postoperative radiological findings.

**Materials and Methods**

This is a prospective, randomized, comparative study on 45 patients with first time recurrent lumbar disc herniation which was conducted in the period between January 2005 and January 2010. Inclusion criteria for this study were: (1) at least 6 months of pain relief after primary lumbar disc surgery; (2) the presence of recurrent radicular pain unresponsive to conservative treatment for at least 6 weeks; and (3) Magnetic resonance imaging (MRI) on lumbosacral spine showing disc herniation at the same level of the primary discectomy. Exclusion criteria in this study were cases with disc herniation with other pathology such as multi segmental spinal canal stenosis, adjacent level disc herniation, spondylolysis, and spinal deformities.

The study was approved by the local research ethics committee, and informed consent was obtained from all patients prior to their inclusion in the study.

**Preoperative evaluation**

All patients had full general and neurological examination. Clinical symptoms and signs were evaluated by direct questioning and examination using the criteria of the Japanese Orthopedic Association’s evaluation system for low back pain syndrome (JOA score)<sup>[1]</sup> as presented in Table 1.

Preoperative investigations included plain X-rays of lumbosacral spine (A-P, Lateral and dynamic films “flexion, extension and oblique”) and MRI with gadolinium enhancement.

**Table 1: Criteria of the Japanese Orthopedic Association’ evaluation system for low back pain syndrome (JOA score)**

Clinical picture	Evaluation	Score
Subjective symptoms (9 points)		
Low back pain (3 points)	None	3
	Occasional, mild	2
	Continuous, mild or occasional, severe	1
	Continuous, severe	0
	Leg pain and/or tingling (3 points)	None
Leg pain and/or tingling (3 points)	Occasional, mild	2
	Continuous, mild or occasional, severe	1
	Continuous, severe	0
Ability to walk (3 points)	Normal	3
	Able to walk farther than 500 m with symptoms*	2
	Able to walk farther than 100 m but less than 500 m	1
	Unable to walk farther than 100 m	0
Objective signs (6 points)		
Straight leg raising test (2 points)	Normal	2
	30°-70°	1
	<30°	0
Sensory disturbance (2 points)	None	2
	Slight	1
	Marked	0
Motor disturbance (2 points)	None	2
	Slight (manual muscle testing 4)	1
	Marked (manual muscle testing 3 to 0)	0
Restriction of daily activities (14 points)		
Turn over while lying (2 points)	Easy	2
	Difficult	1
	Impossible	0
Sitting (about 1 hr) (2 points)	Easy	2
	Difficult	1
	Impossible	0
Standing up (2 points)	Easy	2
	Difficult	1
	Impossible	0
Leaning forward (2 points)	Easy	2
	Difficult	1
	Impossible	0
Lifting or holding heavy object (2 points)	Easy	2
	Difficult	1
	Impossible	0
Washing face (2 points)	Easy	2
	Difficult	1
	Impossible	0
Running (2 points)	Easy	2
	Difficult	1
	Impossible	0

Contd..

**Table 1: Contd...**

Clinical picture	Evaluation	Score
Urinary bladder function (o point)	Normal	0
	Mild dysuria	-3
	Severe dysuria	-6

\*Pain, tingling, numbness and/or muscle weakness; JOA – Japanese Orthopedic Association

### Surgical procedures

The patients were classified into three groups according to the surgical procedure; each group consisted of 15 patients. Group A consisted of patients who had revision discectomy alone, group B consisted of patients who had revision discectomy followed by TLIF then bilateral posterior transpedicular screws fixation, and group C consisted of patients who had revision discectomy followed by bilateral PLF then bilateral posterior transpedicular screws fixation.

All surgeons were efficient in performing the three procedures with the same skill level. Selection of the procedure was done randomly by alternation method to minimize the risk of selection bias. Alternation was done every 3<sup>rd</sup> case according to the following order:

#### Case order Procedure

Case 1	Discectomy alone
Case 2	Discectomy + TLIF + Posterior transpedicular screws fixation
Case 3	Discectomy + PLF + Posterior transpedicular screws fixation

After medication and general anesthesia, all patients were positioned prone on frame or rolls to avoid abdominal compression and reduce venous congestion. All the revision surgeries were performed from the original site of the primary surgery. By using a curette, the epidural scar tissue at the previous laminectomy area was separated from the margin of the residual lamina. Access to the normal anatomic planes of the epidural space was achieved by removal of the residual lamina. The epidural scar tissue was detached and partially resected. Exposure was carried out laterally, so that the lateral edge of the nerve root was visualized. The nerve root was then mobilized gently and retracted medially to expose the disc fragment. Occasionally, the nerve root was adhered to the extruded disc fragment or to the ligamentous structures and required sharp dissection for separation.

In group B and C, facetectomy was done before dissection of the nerve root, until the pedicle was visible. This would facilitate the identification of the nerve root and disc structure for a complete decompression without extensive dissection and retraction of the neural tissues.

In group B, a nearly complete discectomy was performed using disc shavers, curettes, and rongeurs. End-plate decortication

was performed. Intervertebral disc space spreader was then sequentially inserted and opened to restore the normal disc space height. Once the disc space was distracted, a single TLIF PEEK cage (Boomerang, TLIF PEEK Interbody Cages, Medtronic, TN) packed with autogenous bone from the removed residual lamina and the spinous process was inserted. A lateral fluoroscopic image projection was obtained to confirm proper positioning of the cage. Then, the intervertebral disc space spreader was removed. This was followed by bilateral single level posterior transpedicular screws (CD Horaizon M-8, Posterior Transpedicular Systems, Medtronic, TN) fixation under fluoroscopic guidance.

In group C, decortication of the lateral aspect of the superior articular facets, pars interarticulars, and transverse processes was performed bilaterally after discectomy. Autogenous bone graft from the spinous process and the removed residual lamina was placed across the transverse processes on both sides. This was followed by bilateral single level posterior transpedicular screws (CD Horaizon M-8, Posterior Transpedicular Systems, Medtronic, TN) fixation under fluoroscopic guidance.

Closure was then done in a routine fashion after insertion of a subcutaneous suction drain. All patients received prophylactic antibiotics perioperatively and were encouraged to ambulate the day after surgery. The use of lumbar corset for two months was suggested for the patients in group B and C.

### Postoperative evaluation

The patients were followed up at regular intervals for at least two years. Clinical symptoms and signs were evaluated postoperatively by using the criteria of the JOA score<sup>[1]</sup> as presented in Table 1. Results after surgery were assessed according to the recovery rate as described by Hirabayashi *et al.*<sup>[12]</sup> (recovery rate (%) =  $\frac{\text{postoperative score} - \text{preoperative score}}{\text{normal score (29)} - \text{preoperative score}} \times 100$  ).

These results were classified into a four grade scale: Excellent improvement  $\geq 90\%$ , good 75-89%, fair 50-74%, and poor  $\leq 49\%$ .<sup>[1]</sup>

Postoperative plain X-rays of lumbosacral spine (A-P, Lateral and dynamic films “flexion, extension and oblique”) were done at follow-up visits. Postoperative MRI was done only in cases with recurrence of symptoms and complicated cases.

### Statistical analysis

Statistical analysis was performed using SPSS 16.0 for Windows statistic software. Variables were described as frequencies and mean  $\pm$  standard deviation. Paired-Sample T Test was used to compare the differences of pre- and post-operative clinical scores in all patients and in each group of patients. One-way analysis of variance (ANOVA) was used to compare the differences between the three groups with regard to the preoperative data and postoperative clinical outcomes. A  $P < 0.05$  was considered significant.

## Results

Analysis of the preoperative data of all patients in the study was done. There were 25 (55.6%) male subjects and 20 (44.4%) female subjects. The age ranged from 25-62 years with a mean age of 41.4 ( $\pm 10.22$  STD) years. The recurrent time to the primary surgery ranged from 10-30 months with a mean duration of 18 ( $\pm 6.01$  STD) months. The preoperative JOA score ranged from 3-22 with a mean JOA score of 16.4 ( $\pm 5.07$  STD). The operated level was L4-5 in 27 (60%) patients and L5-S1 in 18 (40%) patients. The operated side was the left side in 29 (64.4%) patients and the right side in 16 (35.6%) patients. The duration of follow-up ranged from 24-54 months with a mean follow-up of 37 ( $\pm 7.85$  STD) months.

Statistical analysis of the preoperative data showed no significant difference between the patients in the three groups with regard to age, sex, duration of recurrence, disc level, disc side, and preoperative JOA score [Table 2].

The mean overall JOA score of the patients showed significant improvement from 16.4 ( $\pm 5.07$  STD) (range 3-22) before surgery to 27.3 ( $\pm 3.84$  STD) (range 10-29) at the final follow-up ( $P = 0.000$ ). The mean recovery rate was 87.2 ( $\pm 19.26$  STD)% (range 5%-100%). General clinical outcome, based on recovery rate, was excellent in 26 (57.8%) patients, good in 14 (31.1%) patients, fair in 3 (6.7%) patients, and poor in 2 (4.4%) patients. Satisfactory rate (excellent and good results) was 88.9%.

Comparison between the three groups was done with regard to the postoperative clinical results. It showed no significant difference between the three groups with regard to the mean total postoperative JOA score, recovery rate, and satisfactory rate, but there was significant difference between the three groups with regard to the postoperative low back pain. The postoperative low back pain was significantly higher in group A than that of groups B and C, but there was no significant difference between group B and group C [Table 3].

Two patients in group A required further revision surgery. One patient had discectomy, posterolateral fusion, and transpedicular screws fixation on the same level due to recurrent back pain and sciatica (re-recurrence) and MRI lumbar spine showed recurrent disc herniation (second recurrence) 24 months after surgery. The other patient had posterolateral fusion and transpedicular screws fixation on the same level due to recurrent back pain and severe claudication pain, and MRI and X-ray of the lumbar spine showed spondylolithesis and instability 30 months after surgery. These two patients after their follow-up with regard to this study were stopped at the date of third surgery. Three patients developed temporary foot drop and sensory disturbance on the same side of operation after surgery; two in group A and one in group B and all were treated conservatively and had complete recovery at the end of follow-up. Seven patients had intraoperative dural tear, which was repaired intraoperatively and caused no subsequent

**Table 2: Comparison of patient groups with regard to preoperative data**

	Group A	Group B	Group C	P value
Age (years)	41 ( $\pm 11.10$ STD)	40.5 ( $\pm 9.68$ STD)	42.7 ( $\pm 10.40$ STD)	0.842
Sex (male/female) (%)	53:3/46:7	60/40	53:3/46:7	0.919
Duration of recurrence (months)	17.4 ( $\pm 5.32$ STD)	18.4 ( $\pm 6.57$ STD)	18.1 ( $\pm 6.45$ STD)	0.902
Level L4-5/L5-S1 (%)	66.7/33.3	60/40	53.3/46.7	0.770
Side left/right (%)	66.7/33.3	60/40	66.7/33.3	0.913
Duration of follow up (months)	38.6 ( $\pm 7.73$ STD)	36.3 ( $\pm 8.06$ STD)	36.1 ( $\pm 8.05$ STD)	0.644
Total JOA score	16.7 ( $\pm 4.94$ STD)	15.7 ( $\pm 5.39$ STD)	16.7 ( $\pm 5.18$ STD)	0.840
Low back pain score	1.1 ( $\pm 0.64$ STD)	0.87 ( $\pm 0.74$ STD)	1.1 ( $\pm 0.70$ STD)	0.556
Leg pain and/or tingling score	0.87 ( $\pm 0.35$ STD)	0.93 ( $\pm 0.46$ STD)	0.93 ( $\pm 0.46$ STD)	0.885
Ability to walk score	1 ( $\pm 0.76$ STD)	0.8 ( $\pm 0.77$ STD)	1 ( $\pm 0.76$ STD)	0.711
Straight leg raising test score	0.93 ( $\pm 0.46$ STD)	0.87 ( $\pm 0.35$ STD)	0.87 ( $\pm 0.35$ STD)	0.865
Sensory disturbance score	1.9 ( $\pm 0.26$ STD)	1.9 ( $\pm 0.26$ STD)	1.9 ( $\pm 0.26$ STD)	1.000
Motor disturbance score	1.9 ( $\pm 0.26$ STD)	1.9 ( $\pm 0.26$ STD)	1.9 ( $\pm 0.26$ STD)	1.000
Restriction of daily activities score	9.1 ( $\pm 2.99$ STD)	8.6 ( $\pm 3.25$ STD)	9.2 ( $\pm 3.17$ STD)	0.860
Urinary bladder function score	-0.2 ( $\pm 0.77$ STD)	-0.2 ( $\pm 0.77$ STD)	-0.2 ( $\pm 0.77$ STD)	1.000

JOA – Japanese Orthopedic Association; STD – Standard deviation

**Table 3: Comparison of patient groups with regard to postoperative clinical results**

	Group A	Group B	Group C	P value
Postoperative total JOA score	26.1 ( $\pm 6.54$ STD)	27.9 ( $\pm 0.74$ STD)	27.9 ( $\pm 0.80$ STD)	0.327
Postoperative low back pain score	2.3 ( $\pm 0.88$ STD)	2.9 ( $\pm 0.35$ STD)	2.8 ( $\pm 0.41$ STD)	0.017*
Recovery rate %	82.8 ( $\pm 31.15$ STD)	90.1 ( $\pm 7.73$ STD)	88.8 ( $\pm 10.18$ STD)	0.554
Satisfactory rate %	86.7	93.3	86.7	0.968

\*One-way ANOVA multiple comparison (Post Hoc LSD Test) P value for postoperative low back pain score: Group A-group B=0.009, group A-group C=0.019, group B-group C=0.762

sequelae; four in group A, two in group B, and one in group C. One patient in group B had deep vein thrombosis that treated with conservative treatment and anticoagulant therapy. One patient in group C had superficial wound infection that treated with antibiotic only. List of complications are presented in Table 4.

Comparison between the three groups as regard average intraoperative blood loss, length of operation, length of postoperative hospital stay and total cost of the procedure was done. There was significant difference between the three groups with regard to the intraoperative blood loss and length of operation. The intraoperative blood loss and length of operation were significantly less in group A than the other two groups, but there was no significant difference between group B and group C. The total cost of the procedure was significantly different between the three groups, being least in group A and highest in group B. There was no significant difference between the three groups with regard to the length of postoperative hospital stay [Table 5].

### Discussion

Revision of spinal surgery is more challenging than primary surgery due to the indistinct anatomical planes and perineural scarring.<sup>[13]</sup> Although early reports documented less satisfactory outcomes with revision discectomy,<sup>[13,14]</sup> more investigations which controlled for confounding factors such as foraminal stenosis and adjacent level herniations showed that results are more comparable with those for primary disc surgery.<sup>[1-3,7-10]</sup> Cinotti *et al.*<sup>[7]</sup> found no significant difference in clinical outcome between patients undergoing revision or primary discectomies. Despite finding longer operative times, Suk *et al.*<sup>[3]</sup> similarly found comparable clinical improvement between revision and primary discectomy patients. In matched

cohort study, Papadopoulos *et al.*<sup>[9]</sup> retrospectively found that clinical results, in 27 patients who underwent revision discectomy were not statistically different from those for 30 patients underwent primary discectomy. Our study was conducted on 45 patients with first time recurrent lumbar disc herniation after exclusion of cases with disc herniation with other pathology such as (multi segmental spinal canal stenosis, adjacent level disc herniation, spondylolythesis, and spinal deformities). After a mean follow-up of 37 ( $\pm 7.85$  STD) months, the mean postoperative recovery rate was 87.2% ( $\pm 19.26$  STD) and the satisfactory rate was 88.9%.

Considering these data, patients can be advised that revision discectomy is effective for improving patient's complaint with satisfactory rate up to 88.9%.

The optimal surgical approach for recurrent disc herniation remains a subject of controversy.<sup>[1]</sup> Despite simple revision discectomy can be an effective treatment for first time recurrences,<sup>[1,7-10]</sup> many surgeons would consider the addition of fusion.<sup>[6,11]</sup> Discectomy with fusion has several theoretical advantages. It reduces or eliminates segmental motion and reduces mechanical stresses across the degenerated disc space.<sup>[15]</sup> Lehmann and LaRocca<sup>[16]</sup> treated 36 patients with failed previous lumbar surgery by spinal canal exploration 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. In our study, the patients were classified into three groups according to the surgical procedure. Comparison between the three groups showed better outcomes in fusion groups (group B and group C) than non fusion group (group A) with regard to the mean total postoperative JOA score, recovery rate, and satisfactory rate, but these differences were statistically insignificant ( $P > 0.05$ ). However, the postoperative low back pain was significantly higher in group A than that of group B and C ( $P < 0.05$ ) [Table 3].

Universally, adhesions are present between the disc fragment, annulus, and the overlying neural elements in revision surgery. Developing a plane between these structures can be tedious and difficult and can risk dural tear and neural injury. The incidence of dural tear during repeated lumbar discectomy was reported up to 20% of the patients.<sup>[17,18]</sup> Also, and according to the report by Choi *et al.*,<sup>[19]</sup> permanent foot drop developed in one (2.9%)

**Table 4: Complications**

	Group A (%)	Group B (%)	Group C (%)
Recurrent disc herniation	1 (6.7)	0 (0.0)	0 (0.0)
Postoperative instability	1 (6.7)	0 (0.0)	0 (0.0)
Postoperative neurological deficit	2 (13.3)	1 (6.7)	0 (0.0)
Dural tear	4 (26.7)	2 (13.3)	1 (6.7)
Superficial wound infection	0 (0.0)	0 (0.0)	1 (6.7)
Deep venous thrombosis	0 (0.0)	1 (6.7)	0 (0.0)

**Table 5: Comparison of patient groups with regard to perioperative data**

	Group A	Group B	Group C	P value
Intraoperative blood loss (ml)	256.7 ( $\pm 67.13$ STD)	653.3 ( $\pm 183.68$ STD)	660 ( $\pm 164.97$ STD)	0.000*
Length of operation (min)	125.3 ( $\pm 25.32$ STD)	194 ( $\pm 25.58$ STD)	186 ( $\pm 16.82$ STD)	0.000*
Length of postoperative hospital stay (days)	3.4 ( $\pm 0.74$ STD)	3.5 ( $\pm 1.13$ STD)	3.3 ( $\pm 1.05$ STD)	0.852
Total cost of the procedure (\$)	1520 ( $\pm 36.84$ STD)	2776.7 ( $\pm 56.27$ STD)	2186.7 ( $\pm 52.33$ STD)	0.000*

\*One-Way ANOVA multiple comparison (Post Hoc LSD Test) P value for; intraoperative blood loss: Group A-group B=0.000, group A-group C=0.000, group B-group C=0.902, length of operation: Group A-group B=0.000, group A-group C=0.000, group B-group C=0.345, total cost of the procedure: Group A-group B=0.000, group A-group C=0.000, group B-group C=0.000

of 35 patients after repeated lumbar discectomy. Often this plane is best identified through aggressive facetectomy to enter unscarred virgin tissue. Therefore, the surgeon can approach the disc fragment safely without demanding dissection of the fibrotic scar tissues, and excessive retraction of scarred nerve root and dura.<sup>[20-22]</sup> In our study, there were seven cases of intraoperative dural tear. In group A (non fusion group), where the facet joint was preserved and meticulous dissection of the nerve root and disc fragment from the adhesions has been done, there were four (26.7%) cases with dural tear. While in the fusion groups (group B and C), where more aggressive facetectomy was done to develop a new plane for disc removal away from the adhesions, there was less incidence of dural tear (2 (13.3%) cases in group B and 1 (6.7%) case in group C). For the same reason, the incidence of postoperative transient neurological deficit was higher in the non fusion group than the fusion groups; two (13.3%) cases in group A, one (6.7%) case in group B and no cases in group C had transient postoperative neurological deficit.

If a large portion of the joint was removed during the primary procedure, destabilization of the joint might be anticipated during revision discectomy and this would lead to postoperative mechanical instability.<sup>[13,23]</sup> In our study, there was one case in group A (non fusion group) that developed postoperative spondylolithesis and instability that required another operation 30 months postoperatively for fusion, but none of the cases had postoperative instability in the fusion groups (group B and C).

Many studies proposed that fusion across the disc space reduces, if not, eliminates the risk of recurrent herniation at the level of surgery.<sup>[24-26]</sup> In our study, there was one case of re-recurrent disc herniation in group A (non fusion group) that required third operation for discectomy and fusion 24 months postoperatively, but there were no cases of re-recurrence in the fusion groups (group B and C).

Considering these data, it seems that fusion with revision discectomy improves the postoperative low back pain score, decreases the risk of intraoperative dural tear or neural damage and decreases the postoperative incidence of mechanical instability or re-recurrence.

Fusion with revision lumbar discectomy can be broadly categorized as PLF and interbody fusion. Theoretically, interbody fusion provides the most reliable fusion technique for the lumbar spine. It immobilizes the painful degenerated spinal segments and restores disc height and root canal dimensions, as well as load bearing ability of the anterior structures.<sup>[27]</sup> Various techniques for interbody fusion have been described, including ALIF, PLIF, and TLIF.

ALIF was performed for a recurrent lumbar disc herniation. In a retrospective review of 22 patients who underwent ALIF for recurrent herniation, Choi *et al.*<sup>[28]</sup> found that leg pain,

back pain, and functional status demonstrated statistically significant improvements compared with preoperative values. A total of 19 of the 22 patients (86.3%) were satisfied with their clinical results. The ALIF procedure is technically demanding. The disadvantages of ALIF include the risk of injury to the great vessels or the presacral plexus, which may result in retrograde ejaculation in male patients. ALIF provides limited access to repair dural tears. The technical aspects of ALIF at L5-S1 are also important. The inclined angle of the disc space may be so steep that it renders adequate visualization of the posterior disc margin very difficult.<sup>[28]</sup>

PLIF had been used for surgical treatment of recurrent lumbar disc herniation. Chitnavis *et al.*<sup>[29]</sup> prospectively followed 50 patients with recurrent lumbar disc herniation. After revision discectomy and PLIF, 92% reported significant relief of preoperative symptoms, and 90% stated that they would have the surgery again. The results of PLIF by using a single, threaded, cylindrical cage placed through the contralateral “virgin” side were reported by Niu *et al.*<sup>[30]</sup> in 14 patients with recurrent disc herniations and 93% of patients reported good or excellent outcomes. Similarly, Huang and Chen<sup>[27]</sup> studied 28 patients after PLIF was performed with a single cage and pedicle screws and 92% of patients were satisfied with the clinical results. However, the PLIF procedure is technically difficult and some problems such as graft collapse, slippage, cage migration, dura and nerve root manipulations had been observed in 4 to 10% of the cases with PLIF.<sup>[31-33]</sup>

To avoid the problems and disadvantages of ALIF and PLIF, TLIF had been used for treatment of recurrent lumbar disc herniation. TLIF affords the opportunity to achieve stable three-column fixation through a single posterior surgical approach and unilateral placement of interbody cage.<sup>[20]</sup> Chen *et al.*<sup>[20]</sup> prospectively studied 43 patients who underwent revision discectomy and TLIF for recurrent lumbar disc herniation. After a mean follow-up of 45 months, all patients had significant leg pain improvement and only 86% reported satisfactory outcomes. Complications included two incidental durotomies, one superficial wound infection, and three transient paresthesias that resolved by three months.

The use of PLF had been the predominant surgical modality in the treatment of degenerative spinal conditions.<sup>[16]</sup> Fu *et al.*<sup>[11]</sup> evaluated the results of repeated surgery for recurrent lumbar disc herniation, and compared the results of disc excision with and without PLF. They revealed excellent or good clinical outcomes in 78.3% of patients who had revision discectomy alone (23 patients) and in 83.3% of patients with PLF (18 patients). In the fusion group, there was one superficial infection and two dural tears. Greenleaf *et al.*<sup>[34]</sup> stated that “Although they have used various other techniques in the past, it is the authors’ current preference to perform a stand-alone PLF (when fusion is indicated) in conjunction with revision

discectomy". Also many authors reported that the effect of posterolateral fusion on the adjacent discs was slight in comparison to the anterior (interbody) fusion.<sup>[35,36]</sup>

In our study, we used two types of fusion with revision discectomy; TLIF (group B), and PLF (group C). Comparison between the two groups showed no significant difference between the two groups with regard to the mean total postoperative JOA score, postoperative low back pain score, mean recovery rate, and satisfactory rate. In group B (TLIF group), one patient (6.7%) developed temporary foot drop and sensory disturbance, two patients (13.3%) had intraoperative dural tear and one patient (6.7%) had postoperative deep venous thrombosis. In group C (PLF group), one patient (6.7%) had intraoperative dural tear and one patient (6.7%) had postoperative superficial wound infection. There was no significant difference between both groups with regard to the intraoperative blood loss, length of operation, and length of postoperative hospital stay. However, the total cost of the procedure was significantly higher in group B (TLIF group) than group C (PLIF group). Of note, both groups had significantly higher length of operation, intraoperative blood loss and total cost of the procedure than non fusion group (group A), but there was no significant difference between the three groups with regard to the length of postoperative hospital stay.

Considering these data, we can note that both TLIF and PLF have comparable results when used with revision discectomy but PLF has significantly less total cost than TLIF.

## Conclusion

Revision discectomy is effective in patients with recurrent lumbar disc herniation with satisfactory rate up to 88.9%. Fusion with revision discectomy improves the postoperative low back pain, decreases the intraoperative risk of dural tear or neural damage and decreases the postoperative incidence of mechanical instability or re-recurrence. TLIF and PLF have comparable results when used with revision discectomy, but PLF has significantly less total cost than TLIF.

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