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Management of recurrent unilateral lumbar disc herniation in a single level: unilateral versus bilateral pedicle screws fixation with interbody fusion

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Abstract

Background: Lumbar interbody fusion procedure is a recognized surgical technique in management of a variety of lumbar pathologies including recurrent lumbar disc prolapse. Interbody fusion augmented by pedicle screw fixation has been considered to improve fusion rates and clinical outcomes. Interbody fusion is commonly associated with better fusion potentials through applying the bone graft in the load bearing, vascular position of the anterior, and middle spinal columns. However, it still remains unknown whether interbody fusion with unilateral pedicle screw fixation (UPSF) is superior to that with bilateral pedicle screw fixation (BPSF).

Aim of the work: The aim of this study is to evaluate the efficacy and safety of unilateral versus bilateral pedicle screw fixation associated with interbody fusion for the management of single level unilateral recurrent lumbar disc prolapse as regard the clinical and biomechanical results, operation time, intraoperative blood loss, and postoperative stay.

Material and methods: This observational prospective comparative study of the two groups who were operated either unilateral (group A /15 patients) or bilateral (group B/15 patients) pedicle screw fixation with interbody fusion was done. Patients were followed up for 1, 6, ad 12 months.

Results: Significant improvement in functional outcome of the two groups was noted compared to preoperatively, except in early postoperative period where the back VAS and ODI in the unilateral group was better than bilateral group. However, on further follow up, no significant difference was noticed. There was no significant difference comparing fusion rate, complication rate, and duration of hospital stay between the two groups at postoperative follow-up. There was significantly less blood loss, and significantly shorter operation time in the unilateral PS fixation group as compared with the bilateral PS fixation group in our study.

Conclusion: Our study suggested that TLIF with unilateral PS fixation was as safe and effective as that with bilateral PS fixation for the management of recurrent single level lumbar disc prolapse; it showed better clinical outcome scores of ODI and back VAS, and a significant reduction of the intraoperative blood loss as well as the operation time, without significant differences considering fusion rate, complication rate, and duration of hospital stay between the two groups at postoperative follow-up. However, BPSF with TLIF likely causes more degeneration at the cranial adjacent segment compared with UPSF techniques. Nevertheless, the long-term follow up is required to demonstrate the impact of these findings.

Keywords: Recurrent Lumbar disc prolapse, Unilateral, Bilateral pedicle screw fixation, Interbody fusion

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Introduction

The optimal surgical management for treating recurrent lumbar disc herniation remains controversial [7]. While many authors advocate for repeat discectomy only, particularly in the absence of a distinctive evidence of spinal instability [28], others support the use of different methods of fusion, stating that the addition of pedicle screw instrumented fusion might provide added stability that eliminates segmental motion at the involved level, while adding an interbody fusion prosthesis may further improve the clinical results by improving fusion rates, restoring intervertebral height, and maintaining lumbar lordosis [21].

Various surgical techniques of interbody fusion are under discussion, including anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), and transforaminal lumbar interbody fusion (TLIF) [10].

Over the last decade, transforaminal lumbar interbody fusion (TLIF), initially described by Harms and Jeszenszky in the 1990s [11], has become increasingly popular as a valuable surgical option to manage a variety of lumbar degenerative diseases. It provides the advantages of reducing the potential surgical risk of excessive neural tissue retraction or epidural fibrosis when compared with the posterior lumbar interbody fusion (PLIF) approach [4, 6], besides, eliminating the potential complications associated with anterior lumbar interbody fusion (ALIF), such as retrograde ejaculation following presacral sympathetic plexus iatrogenic injury or possible great vessels damage [9, 18].

In fact, traditionally practiced bilateral pedicle screw fixation (BPSF) and instrumentation performed together with TLIF can be regarded as a reliable and effective surgery for sufficient fusion [16]. On the other hand, it is reported that extreme rigidity caused by bilateral screw fixation may possibly contribute to a higher incidence of adjacent segment disease (ASD) [24]. On the other hand, it is reported in the literature that unilateral pedicle screw fixation (UPSF) with the TLIF procedure has many advantages compared to BPSF including being a less invasive surgical procedure, with shorter operation time, less blood loss, less co-morbidities, less postoperative pain, and less cost [26].

In this study, we evaluated the clinical and radiological results and follow up of our patients subjected to fusion procedure through unilateral versus bilateral PSF along with interbody fusion for the management of recurrent single level unilateral prolapsed lumbar disc, aiming at analyzing the results in comparison to the previously published studies.

Material and methods

This is a prospective, randomized, comparative study on 30 patients with first time recurrent lumbar disc herniation, conducted in the period between January 2016 and December 2018.

The patients were divided according to surgical approach into a unilateral group (group A/15 patients) and a bilateral group (group B/15 patients) who were operated either through unilateral or bilateral pedicle screw fixation with interbody fusion respectively. Patients were followed up for 1, 6, and 12 months. This study occurred at Ain shams university hospitals.

Patient selection

Inclusion criteria

1- Patients with a recurrent single level lumbar disc prolapse at the same level of the primary discectomy with at least 6 months of pain relief following initial lumbar disc surgery.
2- The presence of recurrent strictly unilateral radicular pain unresponsive to conservative treatment for at least 6 weeks.

Exclusion criteria

1. Patient with multiple level recurrent lumbar disc prolapse.
2. Patients with conditions requiring bilateral nerve root decompression, such as bilateral radiculopathy, segmental canal stenosis, spondylolisthesis, and those with spinal osteoporosis.
3. The presence of other lumbar spine pathologies such as trauma, tumor, infection, or deformity.

Preoperative data

1. Clinical evaluation

This will include:

- Patients' demographics (age, sex).
- Relevant past medical and surgical history.
- Clinical presentation and its duration including assessment of:
  - Back pain
  - radiculopathy
  - Visual analogue scale (VAS) and the Oswestry Disability Index (ODI) for both back pain and leg pain.
- Full general and history and neurological examination.

2. Radiological investigation

(A) Plain radiographs

Antero-posterior and lateral (standing and dynamic) views to evaluate:

- Anatomy of the pedicles, transverse processes, laminae, and facet joints; presence of degenerative changes; neural foraminal dimensions, and bone density.
- Measurement of preoperative disc height at the surgical segment, cranial and caudal adjacent segments:

Disc height = (a height + P height)/2.

- To assess stability of the spine on dynamic views where lumbar instability is considered as more than 4.5 mm of translation, and/or 15° to 25° of angular motion between adjacent segments.

(B) MRI

Magnetic resonance imaging (MRI) of the lumbosacral spine with Gadolinium enhancement allowing anatomical evaluation of the spine and spinal canal, nerve roots, and spinal ligaments complex.

Surgical technique

Our patients were classified into two groups according to the surgical procedure; each consisted of 15 patients. All had revision discectomy and interbody fusion using the same interbody cage type (TLIF PEEK Interbody Cages, Medtronic). While group A consisted of patients who had strictly unilateral pedicle screws fixation (UPSF), group B involved patients who had bilateral pedicle screws fixation (BPSF) surgery. All surgeons accounting for performing the two procedures were efficient with the same skill level. Selection of the procedure was done randomly by alternation method to minimize the risk of selection bias.

Following general anesthesia and endotracheal intubation, all patients were positioned prone on Montreal frame or rolls to avoid abdominal compression and subsequent venous congestion. Skin incision was performed at the site of the previous surgery through midline posterior exposure.

Group A patients had unilateral muscle separation at the symptomatic side exposing the facet joints and the transverse processes, whereas the spinous process, supraspinous and interspinous ligaments and the contralateral vertebral plate and facet joints, remained uninjured. Two transpedicular screws were then placed on the symptomatic side, followed by a unilateral hemilaminectomy and medial facetectomy. The symptomatic nerve root is then identified and released carefully. Subsequently, the disc space was to be prepared for cage insertion through discectomy and entire endplate curettage using disc shavers, curettes, and rongeurs. The disc space was then distracted and a single cage filled with autogenous bone graft from the removed residual lamina and is inserted into the disc space. A lateral fluoroscopic image was obtained to ensure safe and proper positioning of the cage.

Group B patients had bilateral subperiosteal muscle stripping and the paraspinal muscles were laterally retracted to the outer edge of the facet joint. Bilateral pedicle screws were implanted followed by full laminectomy and facetectomy at the symptomatic side. Discectomy and cage placement were then carried out.

The fusion level would be moderately compressed by tightening the reduction screws over the rods and hence applying an element of compression over the interbody cage. Intertransverse grafting was also performed.

Finally, closure was performed in a routine fashion over a suction drain. All patients received prophylactic antibiotics perioperatively and were requested to start ambulation on the next day using a lumbar corset for a couple of months. The drains were removed at 48 h.

Evaluation follow up

(A) Clinical outcome

Evaluation of the patient's neurological outcome during the hospital stay as regard postoperative VAS and ODI scores of the two groups for back pain and leg pain in comparison to preoperative scores.

(B) Radiological outcome

Was assessed by plain X-ray (AP, lateral standing, flexion, and extension views).

1. Measurement disc height at the surgical segment, and both cranial and caudal adjacent segments.

Disc height = (a height+ P height)/2.

2. Fusion

Assessment of fusion was carried out according to the Bridwell-Lenke grading system and motion on lateral flexion-extension radiographs:

A. (Grade 1) Definite fusion: definitive bony trabecular bridging across the graft/host interface, no detectable motion on flexion-extension radiographs, and no gap at the interface.

B. (Grade 2) Probable fusion: no definitive bony trabecular crossing, but no detectable motion and no identifiable gap at the interface.
C. (Grade 3) Possible pseudarthrosis: no bony trabecular crossing, no motion, but an identifiable gap at the interface.
D. (Grade 4) Definite pseudarthrosis: no traversing trabecular bone, definitive gap at the interface, and motion on flexion-extension radiographs.

While A and B were considered as successful fusions, C and D were considered as failed fusions.

Statistical analysis

Data were collected, revised, coded, and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations, and ranges when parametric. Also qualitative variables were presented as number and percentages.

The comparison between groups regarding qualitative data was done by using Chi-square test and/or Fisher exact test only when the expected count in any cell found less than 5.

The comparison between two independent groups regarding quantitative data with parametric distribution was done by using Independent *t* test.

The comparison between more than two paired groups regarding quantitative data with parametric distribution was done by using repeated measures ANOVA.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *P* value was considered significant as follows:

$P > 0.05$: nonsignificant (NS)
$P < 0.05$: significant (S)
$P < 0.01$: highly significant (HS)

Results

All the patients' preoperative data was studied and analyzed. There were 21 (70%) males and nine (30%) female patients. Their age ranged from 32 to 55 years in group A with a mean age of 44.21 (± 7.18 STD) years.

In group A subjects, the pathological level was L4-5 in 10 (66.7%) patients, L5-S1 in four (26.7%) patients, and L3–4 in a single case; the left side was the pathological side in 11 (73.3%) patients and the right side accounted for 4 (26.7%) patients. While in group B patients, L4–5 level was involved in eight (53.3%) patients, L5–S1 in five (33.3%) patients, and L3–4 in two (13.4%) cases. The left side was involved in ten (66.7%) cases and five (33.3%) cases had their pathology on the right side.

There was no statistically significant difference found between unilateral group and bilateral group regarding demographic data of the studied patients.

Concerning the VAS score data analysis, there was a highly statistically significant difference between preoperative and postoperative (at 1, 6, and 12 months) VAS of the back pain in both groups; however, on comparing the two groups, there was no statistically significant difference regarding VAS of the back pain except during the first postoperative month, which was significantly lower in unilateral group (3.21 ± 0.72) (Table 1).

Similarly, there was a highly statistically significant difference between preoperative and postoperative (at 1, 6, and 12 months) VAS for the leg pain in both groups, but while comparing between the two groups, there was no statistically significant difference regarding VAS for leg pain postoperatively (Table 2).

Concerning the subjects ODI evaluation, there was highly statistically significant difference found between preoperative and postoperative (at 1, 6, and 12 months) ODI in both groups; however, on comparing between the two groups, there was no statistically significant difference regarding ODI except during the first postoperative month which was significantly lower in unilateral group (*P* value 0.000) (Table 3).

Postoperatively, there was a significant increase in the disc height in both groups. However, there was no statistically difference between the two groups ($P = 0.317$); while on evaluating the adjacent cranial level mean disc height during the postoperative period, it was reduced by 2.82 ± 0.51, 2.01 ± 0.37, and 1.44 ± 0.32 mm at the first, sixth, and twelfth month respectively in the unilateral group, which was significantly ($P < 0.000$) less than the values of 3.31 ± 0.37, 2.55 ± 0.33, and 1.89 ± 0.31 mm in the bilateral group. The adjacent caudal level mean disc height was reduced by 2.47 ± 0.37, 2.14 ± 0.37, and 1.47 ± 0.35 mm at the first, sixth, and twelfth month respectively in the unilateral group, which was statistically insignificantly in comparison with than the values of 2.41 ± 0.33, 2.07 ± 0.34, and 1.52 ± 0.44 mm in the bilateral group.

Our radiological outcome as regard fusion rate was recorded in the unilateral group as 72.0% and 88.0% solid fusion at the sixth and twelfth months respectively while in the bilateral group, it was 76.0% and 92.0% solid fusion the same period respectively, without significant difference between the two groups. There was no statistically significant difference regarding the postoperative complications between the unilateral group and bilateral group.

Unintended durotomy occurred in three patients, two in the bilateral group and a single case in the unilateral group, where the dural tear was repaired intraoperatively via dural sutures augmented by a fat graft, drain was kept superior to the fascia in an non dependant location with no suction then a stitch was taken at its place when removed; no subsequent collection or leakage were recorded in any of the three cases. Cage migration was recorded in a single case in the bilateral group, where the

Table 1 Comparison between unilateral group and bilateral group regarding the visual analogue scale for back pain

VAS back		Unilateral	Bilateral	Test value[a]	*P* value	Sig.
Preoperative	Mean ± SD	7.01 ± 1.41	7.12 ± 1.31	0.303	0.763	NS
	Range	5–9	5–9			
1 month	Mean ± SD	3.21 ± 0.72	4.17 ± 0.69	− 5.000	0.000	HS
	Range	2–4	3–5			
6 months	Mean ± SD	1.77 ± 0.57	1.97 ± 0.71	− 0.778	0.440	NS
	Range	1–3	1–3			
12 months	Mean ± SD	0.81 ± 0.79	0.89 ± 0.67	− 0.376	0.709	NS
	Range	0–2	0–2			
Repeated measures ANOVA	*F*	144.413	147.772			
	P value	< 0.001	< 0.001			

P > 0.05: nonsignificant (NS), *P* < 0.05: significant (S), *P* < 0.01: highly significant
[a]Independent *t* test

patient was presented by acute onset of severe sciatic pain; in the first week postoperatively, plain radiographs and CT scan revealed the migrating cage, patient was reoperated and a larger cage was introduced instead; postoperatively, the patient experienced significant relief of the acute pain.

A single patient of the unilateral group developed temporary foot drop and sensory affection on the same side of operation immediately after surgery; he received conservative medical management and had complete recovery within 1 month.

There was a highly statistically significant difference found between the unilateral and the bilateral group concerning operative time and blood loss being significantly less in the unilateral group, while there was no statistically significant difference regarding the postoperative hospital length of stay (Table 4) (Fig. 1).

Discussion

The use of lumbar fusion together with neural decompression for the management of recurrent disc prolapse cases is a popular surgical option, aiming to maintain disc height, ensure load sharing, and spinal stability [2]; the transforaminal approach for interbody fusion is a recognized practice and remains a sufficient and safe option for fusion particularly in recurrent lumbar disc herniation cases accompanied by radiculopathy with or without mechanical low back ache [16].

While bilateral PS fixation might provide rigid fixation and a consequent satisfactory biomechanical stability and clinical benefits, however, that rigidity may turn the adjacent segment more prone to degeneration process. To minimize the possible side effects at the adjacent levels and try to achieve optimal biomechanical conditions, the use of less rigid fixation systems has been advocated. Hereby, some recent studies questioned the value of unilateral PS fixation as a reliable alternative fusion technique with fewer pedicle screws keeping in mind the distinct nature of revision surgeries with evident perineural scarring and distorted anatomical planes, especially in the presence of strictly unilateral symptoms and the value of

Table 2 Comparison between unilateral group and bilateral group regarding the visual analogue scale for leg pain

VAS back		Unilateral	Bilateral	Test value[a]	*P* value	Sig.
Preoperative	Mean ± SD	7.01 ± 1.32	7.05 ± 1.39	− 0.105	0.917	NS
	Range	5–9	5–9			
1 month	Mean ± SD	1.69 ± 0.77	1.65 ± 0.78	0.190	0.850	HS
	Range	1–3	1–3			
6 months	Mean ± SD	1.14 ± 0.71	1.05 ± 0.55	0.872	0.387	NS
	Range	0–2	0–2			
12 months	Mean ± SD	0.88 ± 0.69	0.79 ± 0.73	0.203	0.840	NS
	Range	0–2	0–2			
Repeated measures ANOVA	*F*	279.159	229.785			
	P value	< 0.001	< 0.001			

[a]Independent *t* test

Table 3 Comparison between unilateral group and bilateral group regarding the Oswestry disability index ODI

ODI		Unilateral	Bilateral	Test value[a]	*P* value	Sig.
Preoperative	Mean ± SD	59.89 ± 9.41	60.84 ± 9.21	0.000	1.000	NS
	Range	45–75	45–75			
1 month	Mean± SD	22.61 ± 3.96	24.44 ± 3.89	− 4.406	0.000	HS
	Range	15–25	20–30			
6 months	Mean± SD	17.55 ± 1.91	16.99 ± 1.87	− 0.522	0.604	NS
	Range	14–20	14–20			
12 months	Mean± SD	14.08 ± 1.32	14.27 ± 1.16	− 0.323	0.748	NS
	Range	12–16	12–16			
Repeated measures ANOVA	*F*	277.744	455.119			
	P value	< 0.001	< 0.001			

[a]Independent *t* test

reserving the intact contralateral elements, which may be a contributor for a possible lower complication rate [17].

Harris et al. described the unilateral TLIF procedure with adjunctive pedicular fixation as an interbody fusion technique that minimizes nerve root manipulation and requires less dissection compared with other interbody fusion methods [12].

In a study conducted by Kim et al. with a 10-year follow-up, higher rates of ASD were recorded in the bilateral PSF group [14]. Likewise, Toyone et al. reported less adjacent segment degeneration in the unilateral PSF group in their study [20]. Other studies available in the literature supported the same view [8, 15, 23].

Nevertheless, it was suggested by an in vitro study that the use of unilateral PS fixation might be detrimental to the fusion process and the spinal instability [17].

Therefore, it remains debatable whether TLIF with unilateral pedicle screw fixation is superior to that with bilateral pedicle screw fixation for the management of recurrent single level lumbar disc herniation syndromes for patients with strictly unilateral symptoms.

Numerous previous studies attempted to evaluate and compare unilateral and bilateral PS fixation approach and results were inconsistent.

Clinical outcomes

Our study was conducted on 30 patients having a recurrent single level lumbar disc prolapse with strictly unilateral symptoms presented with low backache and radicular symptoms who were divided into the unilateral (n = 15) or bilateral (n = 15) pedicle screw fixation groups.

The mean visual analogue score of the back pain for the subjects included in our study showed a highly statistically significant difference between preoperative and postoperative scores at the first, sixth, and twelfth postoperative month in both groups; however, on comparing the two groups, there was no statistically significant difference regarding VAS of the back pain throughout the follow up period except in the first postoperative month, which was significantly lower in unilateral group.

Similarly, our study revealed a highly statistically significant difference between preoperative and postoperative VAS for the leg pain at the first, sixth, and twelfth postoperative month in both groups while there was no statistically significant difference while comparing between the two groups regarding VAS for leg pain.

In agreement with our results, Chen et al. [3] found a highly statistically significant difference between preoperative and postoperative scores for both back pain and leg pain at the first, sixth, and twelfth postoperative

Table 4 Comparison between unilateral group and bilateral group regarding intraoperative data and hospital length of stay

		Unilateral	Bilateral	Test value[a]	*P* value	Sig.
Operation time (min)	Mean ± SD	122.44 ± 14.21	164.32 ± 14.22	− 10.524	0.000	HS
	Range	115–160	120–190			
Blood loss (ml)	Mean ± SD	441.00 ± 116.57	740.00 ± 182.14	− 6.338	0.000	HS
	Range	200–600	300–1100			
Hospital length of stay (days)	Mean ± SD	3.71 ± 0.88	4.52 ± 0.61	− 1.639	0.108	NS
	Range	3–5	4–6			

[a]Independent *t* test

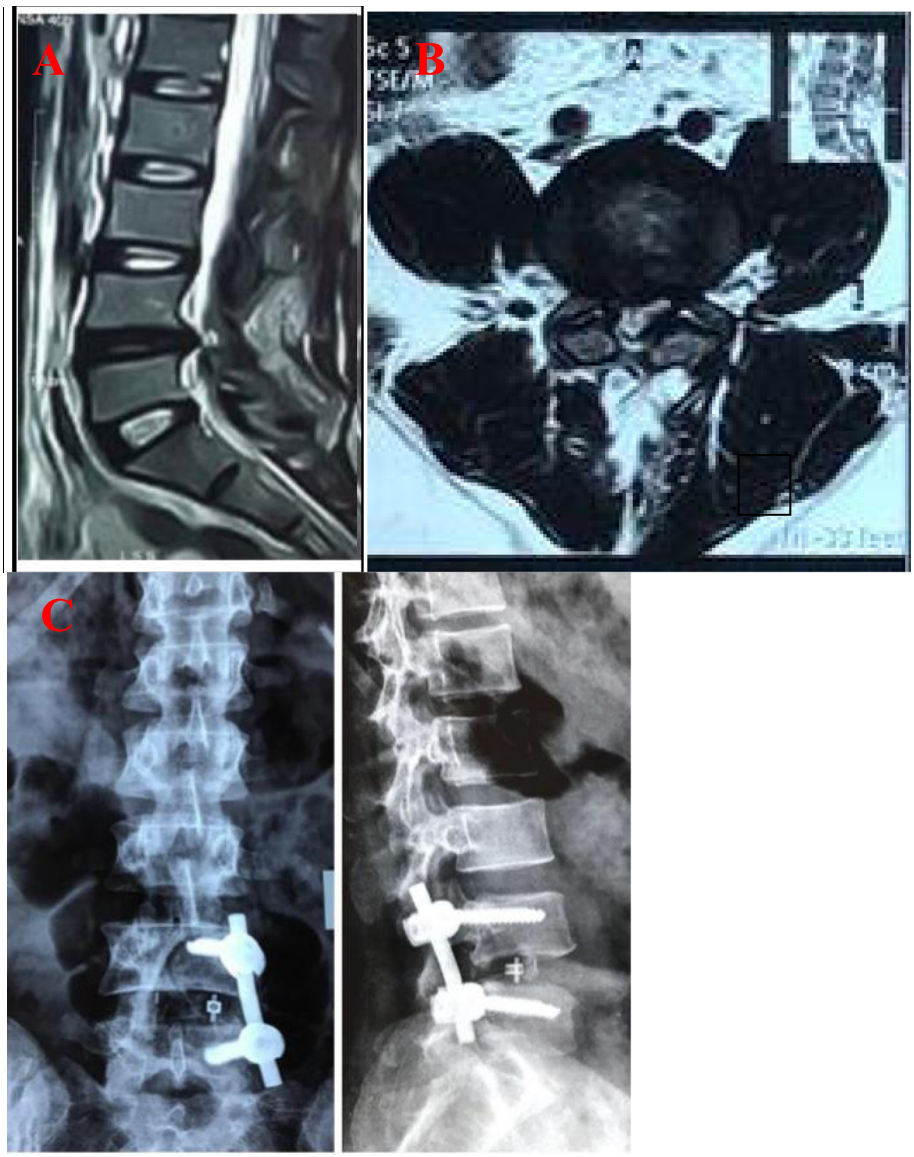

Fig. 1 Images of 40-year-old female patient with recurrent L4–5 disc prolapse presented with LBP and Right sciatica. Preoperative MRI lumbosacral spine. **a** Sagittal T2-weighted image and **b** axial T2WI showing recurrent LDP of L4–5 level. **c** Postoperative 12 months follow up plain x-ray lumbosacral spine AP view and lateral view with unilateral transpedicular screw fixation at L4–5

month in both groups; and, on comparing the two groups, there was a statistically significant difference regarding VAS of the back pain in the first postoperative month, which was significantly lower in unilateral group; otherwise, there was no statistically significant difference regarding VAS of the back pain throughout the follow up period.

Numerous authors reported similar results, including Işik et al. [13], Yang et al. [25], and Villavicencio et al. [22].

Zhang et al. [27] described a statistically significant difference between preoperative and postoperative VAS for both back pain and leg pain at 6, 12, and 24 months postoperatively in both unilateral and bilateral groups, while on comparing between the two groups, there was no statistically significant differences found throughout the whole follow up period.

In comparison between the two groups included in our study, there was a highly statistically significant difference found between preoperative and postoperative at 1, 6, and 12 months concerning the mean ODI score in both groups; however, on comparing between both groups, there was no statistically significant difference regarding ODI except during the first postoperative month which was significantly lower in unilateral group.

Chen et al. (3) stated no statistically significant difference comparing ODI scores between the two groups at whole postoperative follow-up.

On the other hand, Işik et al. [13] observed a slight increase in VAS and ODI scores in both groups as their follow up got longer; they theorized that the natural process of degeneration develops by time and this increase may be induced by an adjacent segment degeneration that has developed or may develop in the future in all patients undergoing instrumented fusion. Within this framework, the need for longer follow-up is strongly considered.

Concerning the mean disc height at the surgical segment, our study showed there was a significant postoperative increase in the disc height in both groups while there was no statistically difference between the two groups. However, on evaluating the adjacent cranial level during the postoperative period, there was a reduction in mean disc height in the unilateral group at 1 year postoperatively, which was highly significantly less than the values of the bilateral group, unlike the adjacent caudal level mean disc height that was reduced postoperatively in both groups with statistically insignificant values.

Close to our results, Chen et al. [3] reported that after UPSF with interbody fusion, the mean disc height of the surgical segments has increased postoperatively, which was significantly less than the bilateral group; the mean disc height of adjacent cranial levels was reduced, significantly less than the values in the bilateral group, whereas the mean disc height of caudal level was reduced with no statistically significant difference between both groups. Similarly, Villavicencio et al. [22] reported a statistically significant mean disc height increase in both groups postoperatively; however, they pointed a finger to a statistically significant foraminal height loss detected in the bilateral group compared to foraminal height loss in the unilateral group that was not statistically significant. In contrary, Dahdaleh et al. [5] did not demonstrate any radiographic evidence of adjacent segment degeneration during the whole 1 year follow-up period in their study.

In terms of operation time, it is understood that the group subjected to unilateral screw fixation had significantly shorter surgery time, which is in accordance with the literature.

Our study described a mean operative time for patients of the unilateral group patients to be 122.44 ± 14.21 min, the longest operative time was 160 min, and the shortest was 115 min; while that in the bilateral group was 164.32 ± 14.22 min, the longest operative time was 190 min, and the shortest was 120 min. The mean operative time for the unilateral and the bilateral group according to Işik et al.'s [13] study was 111.7 ± 24.31 min and 158.6 ± 18.30 min respectively, a result close to ours; a lesser mean operative time was noted by Chen et al. [3], being 89.8 ± 19.7 min in the unilateral group and 109.1 ± 15.3 min in the bilateral group, while Zhang et al. [27] recorded a longer mean operative time of 208 (126–275) minutes and 257 (158–300) respectively.

The use of bilateral PS fixation is associated with another drawback which is more blood loss, since it is inevitable to have more blood loss during neural elements decompression along with screws application on both sides. This is a clear-cut fact reported in all studies [2, 8, 19, 23, 24].

Likewise, in our study, in line with the literature, we noted significantly less blood loss in the unilateral group; the mean intraoperative blood loss for subjects in the unilateral group was 441.00 ± 116.57 ml, the largest amount being 600 ml and the smallest amount was 200 ml, while in bilateral group was 740.00 ± 182.14 ml, the largest operative time being 1100 ml and the smallest was 300 ml.

In our study, the mean hospital length of stay was 3.71 ± 0.88 days for the unilateral group cases ranging from 3 days recorded as the shortest up to 5 days as the longest hospital stay, while it was 4.52 ± 0.61 days in the bilateral group subjects and ranging between 4 and 6 days as the shortest and the longest recorded hospital stays respectively. Some studies recorded longer mean hospital stays as both Chen et al. [3] and Zhang et al. [27].

Concerning the radiological outcome, numerous authors reported similar results regarding the fusion rate at 6 and 12 months postoperatively without significant difference between the two group including Chen et al. [3], Işik et al. [13], Villavicencio et al. [22], and Yang et al. [25].

Intraoperative complications included unintended durotomy that took place in three patients, two in the bilateral group and a single case in the unilateral group, where the dural tear was repaired intraoperatively via dural sutures augmented by a fat graft and no lumbar drain was required. Yang et al. [24] reported also three cases to have a dural tear, again one in unilateral group and two in bilateral group. All were managed conservatively as well with no occurrence of any further complications.

Cage migration was recorded in a single case in the bilateral group, where the patient was presented by acute onset of severe sciatic pain; in the first week postoperatively, plain radiographs and CT scan revealed the migrating cage, patient was reoperated and a larger cage was introduced instead; postoperatively, the patient experienced significant relief of the acute pain.

In 2012, Aoki et al. [1] reported cage migration in two patients in the unilateral PS fixation group and a single in the bilateral fixation group; cage migration was diagnosed 3 months after surgery. Only a single patient in the bilateral group required revision surgery as a result of nerve root irritation, while the other two patients had no harmful symptoms and received conservative observation.

There was no statistically significant difference between both groups regarding the postoperative complications.

Conclusion

Our study suggested that unilateral PS fixation with interbody fusion is a safe technique that provides satisfactory short-term and medium-term results in treating single-level recurrent lumbar disc prolapse in selected patients; it is as effective as the bilateral PS fixation techniques significantly reducing the operative duration as well as the intraoperative blood loss, provides a satisfactory improvement of the clinical outcome scores of ODI and VAS of the back and leg without significant difference between the two groups regarding the fusion rate, complications rate, or the duration of hospital stay. BPSF with interbody fusion likely causes more degeneration at the cranial adjacent segment compared with UPSF techniques. However, further randomized controlled trials and long-term evaluation would be necessary to demonstrate the impact of this findings.

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Authors' contributions
The study design, execution and follow up of the clinical cases, data analysis and results formulation, and writing of the manuscript were all the joint work of all the authors. This work was entirely carried out by the authors without any external contributions. All authors read and approved the final manuscript.

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Availability of data and materials
All the raw data and results of the statistical analysis are available with the authors and ready to be shared with authorized personnel upon request; however, for reasons of patency protection, it was not submitted with the manuscript.

Ethics approval and consent to participate
This research was conducted upon obtaining the approval of the ethical committee of the Faculty of Medicine- Ain Shams University, in July 2015. Since this study involved human subjects, an informed consent was signed and acquired from all the participants or their legal guardians in accordance with the ethical committee recommendations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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