Unilateral versus bilateral instrumentation with lumbar interbody fusion for degenerative lumbar diseases: a retrospective study

Tameem M. Elkhateeb, Hany EL Zahlawy, Mohammed A. Hussien

Department of Orthopedics and Spine Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Tameem Mohamed Elkhateeb, Residence, 79 El Nasr Road, Nasr City, Cairo, Egypt
Tel: (+202)23854555; Mobile: (+20100)1809052; e-mail: tameem_77@hotmail.com

Received: 16 September 2023
Revised: 26 September 2023
Accepted: 01 October 2023
Published: 27 January 2024

The Egyptian Orthopaedic Journal 2023, 58:311–315

Purpose
To assess the clinical and radiological outcomes of patients experiencing fusion technique by unilateral versus bilateral instrumentation with interbody lumbar fusion.
Materials and methods
Fifty-nine patients were included in this study. Thirty-six patients were managed with bilateral PSF and interbody fusion, and 23 had unilateral PSF and interbody fusion. Clinically, the patients were evaluated using the mJOA score. They were followed up for a minimum period of 3 years. Fusion at follow-up was established using radiographs.
Results
Procedure periods were quicker, and blood loss was fewer in the unilateral group. Fusion rates were comparable in both groups with insignificant differences. There was a statistically significant difference in clinical improvement of JOA scores in both groups.
Conclusion
Unilateral pedicle screw fixation together with interbody fusion is an efficient choice in chosen cases. Prospective, randomized research with a higher number of cases and longer follow-up times is required for more consistent outcomes.

Keywords:
bilateral fixation, degenerative lumbar disease, interbody fusion, unilateral fixation

Egypt Orthop J 2023, 58:311–315

1110-1148

Introduction

The significance of lumbar degenerative spondylosis has been enhanced recently due to advances in diagnostic tools [1,2]. Most of the affected cases is managed conservatively, as for the surgical option, lumbar fusion is an established effective technique for management [3], attaining strong arthrodesis, and immobilizing the unstable segment [4]. Bilateral pedicle screw fixation with interbody fusion is an efficient, dependable, and biomechanically adequate technique for fusion [1,2,5,6]; nevertheless, it is stated that rigid fusion would accelerate the degeneration of nearby levels. A debate has recently been rising on whether the pedicle screw fixation should be applied unilaterally or bilaterally [7,8]. Unilateral pedicular fixation with interbody fusion has various benefits compared with bilateral. The benefits are that it is a less invasive operative technique with reduced blood loss, shorter surgery period, less postoperative pain, shorter hospital stay, lower cost, and less likelihood to cause an adjacent segment disease (ASD) [9–12].

However, various studies reported that unilateral fixation reduces stability and rigidity during axial rotational and lateral bending, which was observed with a lower fusion rate, resulting in more cage subsidence and migration incidents and being inappropriate for long-segment stabilization [13–16].

This study aimed to assess the radiologic and clinical outcomes of the fusion technique using bilateral versus unilateral instrumentation with interbody fusion.

Materials and methods

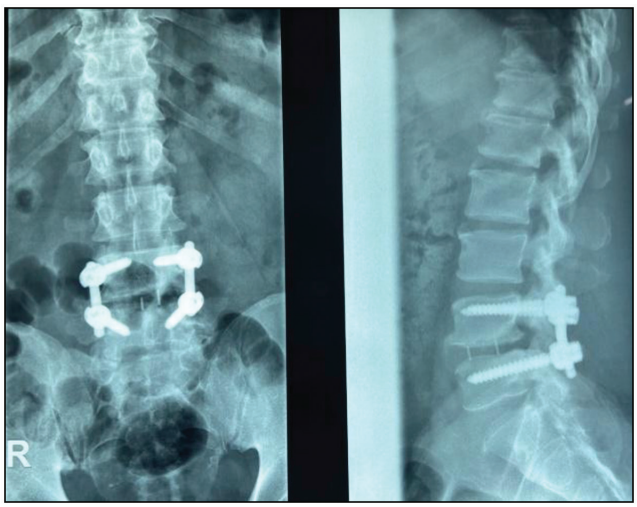
This retrospective study was done on 59 cases following the ethics committee regulations in our institute, and informed consent was taken from each case. All cases were operated on at our hospitals between March 2013 and March 2018 with interbody fusion and either unilateral or bilateral PSF. Inclusion criteria were patients with single-level fusion for degenerative lumbar spondylosis with a minimum follow-up period of 3 years. Patients with multiple levels of fusion, with more than Grade 1 spondylolisthesis, post-traumatic fusion, pathological conditions, severe comorbid conditions, and revision surgeons were excluded from this study.

All cases had varying degrees of low back pain, leg pain, and neurological symptoms. Each case was conservatively managed initially; upon failure of medical treatment, preoperative evaluation was done by lumbar spine X-rays, MRI, and CT scan if needed. Bilateral instrumentation was done in 36 cases compared with unilateral instrumentation in 23 cases. Demographic data were collected including age, gender, diagnosis, and fusion level. Also, operative data including procedure time, intraoperative blood loss, and intraoperative complications were retrieved from records. The length of hospital stay of each case was also documented. Early postoperative complications such as CSF leak, screw malposition, wound infection, and thromboembolism were assessed. During follow-ups, data related to screw failure, cage migration, fusion, and adjacent segment disease were documented.

Figure 1

The A-P and a lateral view showing unilateral pedicle screw fixation and solid bony fusion.

Figure 2



The A-P and a lateral view showing bilateral pedicle screw fixation and solid bony fusion.

Functional assessment was done using the mJOA score. The minimum follow-up period was 3 years. mJOA scores were retrieved and compared. Solid fusion diagnosis was established using radiographs showing bone trabecular continuousness on X-rays and CT. (Figs. 1, 2) Screw breakage was also considered a sign of failed fusion.

Statistics reviews were accomplished using SPSS v13.0. Wilcoxon signed rank analysis was applied to compare many interpretations of similar variables. Chi- square (c2) analysis was applied to compare the frequency of qualitative variables between different cohorts. Spearman's correlation analysis was applied for correlating nonparametric variables. For all analyses, a p-value < 0.05 was measured as significant, and <0.001 was highly significant. Consistent with this test results, the results were stated as a sample size, mean with standard deviation.

The operative procedure was performed under GA in the prone position, after the posterior median incision, the paraspinal muscles were subperiosteally elevated at the symptomatic side in the unilateral cohort and at both sides in the bilateral. Image-guided polyaxially pedicle screw insertion unilaterally and bilaterally, hemilaminectomy, and facetectomy were performed in both groups. The crossing root was identified and retracted to reveal the intervertebral disk. Discectomy, endplate preparation, along with neural element decompression were done, followed by impaction of morselized autogenous bone graft plus intervertebral cage (PEEK). This provides sufficient biomechanical stability till rigid bone union. Then pre-contoured rods were inserted into the screws to preserve the sagittal profile. Compression over rods was done to assure cage settlement and enhance the chances of graft fusion. The spinal canal was finally inspected to exclude any neuronal compression. Posterolateral fusion was also done along the full length of the spinal instrumentation.

Results

Demographic data are outlined in Table 1.

No statistical variance was noticed between both cohorts regarding age, gender, diagnosis, fusion level, and preoperative mJOA score (both in individual parameters and the entire score). There was a statistically highly significant difference between the unilateral and bilateral cohorts as regards operative time, and the length of hospital stay is significantly shorter in the unilateral cohort as shown in Table 2. Also, blood loss was significantly less in unilateral cases.

The minimal follow-up period was 3 years in both cohorts. There was a statistically significant variance

in the progress of the mJOA score in both cohorts. On comparing both cohorts, the results exhibited no significant variance in postoperative mJOA score. Both procedures improved back and leg pain as well as disability with no variations in results between both cohorts (Table 3).

The fusion rate was comparable in both cohorts with no statistically significant difference between both groups (Table 4). As for the complications, superficial wound infection was noticed in each group, and both were managed conservatively with antibiotics and daily dressing. No perioperative complications were detected in any of the cases in this study. None of the patients had screw failure or cage migration during follow-ups. The rates of ASD were comparable in both groups, with one case in the unilateral cohort and two in the bilateral cohort. All the three ASD cases were individuals who were followed up for more than 2 years. None of the patients needed reoperation during the follow-up period.

Table 1 Demographic data

	Unilateral (*n*=23)	Bilateral (*n*=36)	*P* value
Age (years)	54.1 ± 8.34	54.15 ± 7.9	>0.05
Male: female	10:13	14:22	>0.05
Level			
L5-S1	5	11	
L4-L5	13	19	
L3-L4	3	5	>0.05
L2-L3	2	1	
Diagnosis			
DDD	11	14	>0.05
LCS	9	15	
Listhesis	3	7	
Follow-up (months)	34.52 ± 9.6	36.45 ± 10.1	>0.05

DDD, degenerative disk Disease; LCS, lumbar canal stenosis.

Discussion

The fusion technique following neural decompression is the gold standard operative management of lumbar degenerative disorders. The main goal is to attain lumbar stability, preserve the disk space height, and maximize load sharing with the anterior column. [2,12,14] The TLIF technique described by Harms is the most widely established method for fusion. [1,11] In this study, all cases of both cohorts had the TLIF technique and attained a comparable proper fusion at the end of follow-up (minimal three years). Bilateral pedicle screw fixation is the universally used method in degenerative lumbar disease cases necessitating fusion [1,5,13,17] by achieving adequate biomechanical stability and rigid fixation. [9] Yet, studies with long-standing follow-up state that the fusion rate drops, the likelihood of pseudoarthrosis development gets higher, osteoporosis in the adjacent segments increases, and the chances of ASD turn higher. [18,19] The idea of unilateral pedicle screw fixation was first introduced by Goel *et al.* [20] in 1991, followed by multiple reports using unilateral PSF with TLIF all reporting an appropriate and efficient fusion. A systematic review published by Molinari *et al.* [14] in 2015 reported a comparable fusion rate between unilateral and bilateral screw fixation. Also, in a recently published study by Badikillaya *et al*. [21] in 2021 with medium-term follow-up, comparable fusion rates were found.

On the contrary, some biomechanical studies reported reduced rotational stability affecting fusion seen with unilateral pedicular fixation [11,22]. In a biomechanical review by Ambati *et al.*, [23] fixation using bilateral pedicle screws had higher biomechanical stability, reduced stresses on instrumentation, and improved fusion construct.

Table 2 Clinical Outcomes

	Unilateral (*n*=23)	Bilateral (*n*=36)	*P* value
Operative time (min)	100.53 ± 21.88	142.7 ± 16.40	<0.001
Blood loss (ml)	136.0 ± 34.90	195.1 ± 80.57	<0.05
Hospital stay (days)	3.77 ± 1.30	5.58 ± 1.79	<0.001

Table 3 Preoperative and postoperative JOA scores in both groups

	Unilateral			Bilateral			Between group P-value[2]
	Pre-op	Post-op	Within group P-value[1]	Pre-op	Post-op	Within group P-value[1]	
Total JOA score	15 ± 1.9	23.9 ± 1.9	0.000	14.15 ± 1.8	25.15 ± 1.4	0.000	>0.05
Back pain	0.6 ± 0.5	2.2 ± 0.6	0.000	0.4 ± 0.5	2.05 ± 0.6	0.000	>0.05
Leg pain	1.25 ± 0.55	2.85 ± 0.37	0.000	1.4 ± 0.5	2.7 ± 0.47	0.000	>0.05
ADL[3]	7.2 ± 1.2	10.2 ± 1.2	0.000	6.35 ± 1.4	12 ± 1.03	0.000	>0.05

[1] *P* value when comparing the results preoperatively and postoperatively within the same surgical group.
[2] *P* value when comparing postoperative results between the two surgical groups.
[3] Activities of daily living.

Table 4 Fusion rate

	Unilateral (*n*=23)	Bilateral (*n*=36)	*P* value
Fusion	22 [95.65%]	34 [94.4%]	>0.05
Nonunion	1 [4.34%]	2 [5.55%]	>0.05

Regarding the number of fusion levels, where unilateral PSF was applied in previous reports, Chen *et al.*, Yang *et al.*, and Nie *et al.* [9,16,24] stated that it is more appropriate to be applied at single-level fusion to avoid increased rotational instability Others as Xue *et al.*, Zhang *et al.*, and Mao *et al.* [18,25,26] reported satisfactory outcomes for two levels fusions. A wider agreement is in preference of using unilateral pedicular fixation for single-level fusions. [16,27] In this study, we incorporated only single-level fusion cases. Significantly shorter operative time, lower blood loss, and shorter hospital stay with unilateral cohort were found in this study, which is comparable to previous reports in the literature [5,9,16,18,27].

Functional assessment using JOA was also comparable to previous studies with no significant difference between both groups; both showed significant improvement postoperatively.

Higher rates of cage subsidence and migration were found in previous literature in unilateral groups [7,19]; other complications occurred at the same rate in both fixation methods in previous literature [14,19]. Being a well-known complication with instrumented fusion more than noninstrumented fusion, ASD is thoroughly investigated in all studies reporting spinal fusions [2,10,28]. In their studies, Kim *et al.* [10] and Toyone *et al.* [29] found higher rates of ASD when using bilateral pedicular fixation than unilateral fixation.

As for our study, there was no statistically significant difference between ASD rates in both cohorts, with one case in the unilateral and two cases in the bilateral cohort.

This study had a few limitations, being a retrospective study on previously available records, and a small number of the included cases.

Conclusion

Single-level lumbar degenerative spondylosiscan be efficiently and safely managed using either unilateral or bilateral pedicular screw fixation techniques combined with TLIF.

Acknowledgements

Nil.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Ethical Approval

The study was done following the approval of the research Ethics Committee of Faculty of Medicine, Ain Shams University.

Study Design

A retrospective case series study (Level IV).

Author Contribution

1-Tameem Mohamed Elkhateeb, MD (Contribution: study design, manuscript preparation, surgical intervention, database creation, research writing). 2-Hany EL Zahlawy, MD (Contribution: Research idea, Study plan, Collection of scientific material, Surgical intervention, Database creation, Research writing, Performed measurements, and manuscript preparation,). 3-Mohammed Ali Hussien, MD (Contribution: Database creation, Research writing, Performed measurements, and manuscript preparation,).

References

1 Hu XQ, Wu XL, Xu C, Zheng XH, Jin YL, Wu LJ, *et al*. A systematic review and meta-analysis of unilateral versus bilateral pedicle screw fixation in transforaminal lumbar interbody fusion. PLoS One 2014; 9:e87501.

2 Işik HS, Okutan Ö, Yildirim T, Akpinar E, Yilmaz A. Comparison of unilateral versus bilateral pedicle screw fixation in transforaminal lumbar interbody fusion for single level lumbar degenerative diseases and review of literature. Turk Neurosurg 2017 Jul 30. doi: 10.5137/1019-5149.JTN.20531-17.1. Online ahead of print.

3 Bydon M, De la Garza-Ramos R, Macki M, Baker A, Gokaslan AK, Bydon A. Lumbar fusion versus nonoperative management for treatment of discogenic low back pain: a systematic review and meta-analysis of randomized controlled trials. J Spinal Disord Tech; 2014 27:297–304.

4 Liu WB, Zhao WT, Shen P, Zhang FJ. The effects of bisphosphonates on osteoporotic patients after lumbar fusion: a meta- analysis. Drug Des Devel Ther 2018 12:2233–40.

5 Ding W, Chen Y, Liu H, Wang J, Zheng Z. Comparison of unilateral versus bilateral pedicle screw fixation in lumbar interbody fusion: A meta-analysis. Eur Spine J 2014; 23:395–403.

6 Liu F, Feng Z, Zhou X, Liang Y, Jiang C, Li X, Li Z, Jiang X, Dong J. Unilateral versus bilateral pedicle screw fixation in transforaminal lumbar interbody fusion: A monocentric study of 215 patients with a minimum of 4-year follow-up. Clin Spine Surg 2017; 30:E776–E783.

7 Aoki Y, Yamagata M, Nakajima F, Ikeda Y, Shimizu K, Yoshihara M, Iwasaki J, Toyone T, Nakagawa K, Nakajima A, Takahashi K, Ohtori S. Examining risk factors for posterior migration of fusion cages following transforaminal lumbar interbody fusion: A possible limitation of unilateral pedicle screw fixation. J Neurosurg Spine 2010; 13:381–387.

8 Li Z, Liu F, Liu S, Chen Z, Jiang C, Feng Z, Jiang X. Mini open transforaminal lumbar interbody fusion with unilateral fixation: A comparison between ipsilateral and contralateral reherniation. Biomed Res Int 2016:7261027. doi: 10.1155/2016/7261027.

9 Chen C, Cao X, Zou L, Hao G, Zhou Z, Zhang G. Minimally invasive unilateral versus bilateral technique in performing single-segment pedicle

screw fixation and lumbar interbody fusion. J Orthop Surg Res 2015; 10:112.

10 Kim TH, Lee BH, Moon SH, Lee SH, Lee HM. Comparison of adjacent segment degeneration after successful posterolateral fusion with unilateral or bilateral pedicle screw instrumentation: A minimum 10- year follow-up. Spine J 2013; 13:1208–1216.

11 Rihn JA. Commentary: Is bilateral pedicle screw fixation necessary when performing a transforaminal lumbar interbody fusion? An analysis of clinical outcomes, radiographic outcomes, and cost. Spine J 2012; 12:216-217.

12 Zhao CQ, Ding W, Zhang K, Zhao J. Transforaminal lumbar interbody fusion using one diagonal fusion cage with unilateral pedicle screw fixation for treatment of massive lumbar disc herniation. Indian J Orthop 2016; 50:473–478.

13 Liu F, Feng Z, Zhou X, Liang Y, Jiang C, Li X, *et al*. Unilateral versus bilateral pedicle screw fixation in transforaminal lumbar interbody fusion: A monocentric study of 215 patients with a minimum of 4-year follow-up. Clin Spine Surg 2017; 30:E776–E783.

14 Molinari R, Saleh A, Molinari R Jr, Hermsmeyer J, Dettor JR. Unilateral versus bilateral instrumentation in spinal surgery: A systematic review. Glob Spine J 2015; 5:185–194.

15 Zhao Y, Yang S, Ding W. Unilateral versus bilateral pedicle screw fixation in lumbar fusion: A systematic review of overlapping meta- analyses. PLoS One 2019; 14:e0226848.

16 Yang SD, Chen Q, Ding WY, Zhao JQ, Zhang YZ, Shen Y, Yang DL. Unilateral pedicle screw fixation with bone graft vs. bilateral pedicle screw fixation with bone graft or cage: A comparative study. Med Sci Monit 2016; 22:890–897.

17 Quante M, Kesten H, Richter A, Halm H: Transforaminal lumbar interbody fusion for the treatment of degenerative spondylolisthesis. Orthopade 2012; 41:153–162.

18 Cheng X, Zhang K, Sun X, Tian H, Zhao C, Zhao J. Unilateral versus bilateral pedicle screw fixation with transforaminal lumbar interbody fusion for treatment of lumbar foraminal stenosis. Spine J 2022; 7:S1529–9430. (22)00241-8

19 Yuan C, Chen K, Zhang H, Zhang H, He S. Unilateral versus bilateral pedicle screw fixation in lumbar interbody fusion: A meta-analysis of complication and fusion rate. Clin Neurol Neurosurg 2014 117:28–32.

20 Goel VK, Lim TH, Gwon J, Chen JY, Winterbottom JM, Park JB, Weinstein JN, Ahn JY. Effects of rigidity of an internal fixation device. A comprehensive biomechanical investigation. Spine 1991; 16 (Suppl 3):S155–161.

21 Badikillaya V, Akbari KK, Sudarshan P, Suthar H, Venkatesan M, Hegde SK. Comparative analysis of unilateral versus bilateral instrumentation in TLIF for lumbar degenerative disorder: single center large series. Int J Spine Surg. 2021; 15:929–936.

22 Rivet DJ, Jeck D, Brennan J, Epstein A, Lauryssen C. Clinical outcomes and complications associated with pedicle screw fixation-augmented lumbar interbody fusion. J Neurosurg Spine 2004; 1:261–266.

23 Ambati DV, Wright EKJr, Lehman RAJr, Kang DG, Wagner SC, Dmitriev AE. Bilateral pedicle screw fixation provides superior biomechanical stability in transforaminal lumbar interbody fusion: A finite element study. Spine J 2015; 15:1812–1822.

24 Nie T, Chen DJ, Tang B, Song Q, Liu X, Zhang B, *et al*. In vivo dynamic motion characteristics of the lower lumbar spine: L4-5 lumbar degenerative disc diseases undergoing unilateral or bilateral pedicle screw fixation combined with TLIF. J Orthop Surg Res 2019; 14:171.

25 Mao L, Chen GD, Xu XM, Guo Z, Yang HL. Comparison of lumbar interbody fusion performed with unilateral or bilateral pedicle screw. Orthopedics 2013; 36:e489–493.

26 Zhang K, Zhao J, Sun W, Zhao CQ, Li H, Ding W, Xie YZ, Sun XJ. Unilateral versus bilateral instrumented transforaminal lumbar interbody fusion in two-level degenerative lumbar disorders: A prospective randomized study. Int Orthop 2014; 38:111–116.

27 Shen X, Wang L, Zhang H, Gu X, Gu G, He S. Radiographic analysis of one-level minimally invasive transforaminal lumbar interbody fusion (MI- TLIF) with unilateral pedicle screw fixation for lumbar degenerative diseases. Clin Spine Surg 2016; 29:E1.

28 Yamasaki K, Hoshino M, Omori K, Igarashi H, Nemoto Y, Tsuruta T, *et al*. Risk factors of adjacent segment disease after transforaminal inter-body fusion for degenerative lumbar disease. Spine 2017; 42:E86–92.

29 Toyone T, Ozawa T, Kamikawa K, Watanabe A, Matsuki K, Yamashita T, *et al*. Subsequent vertebral fractures following spinal fusion surgery for degenerative lumbar disease: A mean ten-year follow-up. Spine 2010; 35:1915–1918.