

# Clinical and Radiological Outcomes of Surgery for Lumbar Degenerative Spondylolisthesis and Its Impact on Interbody Fusion Cage

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## ARTICLE INFO

Received: 22 September 2026  
Accepted: 27 September 2026  
Published Online: 3 October 2026

DOI: 10.5281/zenodo.23118054

Volume: 10, Number: 3, Page: 812-815

e-ISSN: 2789-5912  
ISSN: 2617-0817

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## ABSTRACT

**Background:** Lumbar degenerative spondylolisthesis (LDS) involves the slippage of a lumbar vertebra, typically less than 30-40%, to avoid severe neurological symptoms. Affecting 5-7% of the general population, it's common in older women, particularly at L4-L5 levels. Most LDS patients are asymptomatic or have mild symptoms manageable with conservative treatment, but surgery is needed for refractory cases. Surgical goals include neural decompression and spine stabilization, using techniques like decompression, fusion, and instrumentation. The introduction of interbody cages aims to enhance fusion and maintain vertebral reduction, though no universal surgical consensus exists. **Aim of the study:** The study aims to compare the radiological and clinical outcomes of surgical treatment for L4-L5 lumbar degenerative spondylolisthesis (LDS) with and without the use of an interbody fusion cage. **Methods & Materials:** The study was conducted at the Department of Orthopedics in Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh from January 2024 to December 2024. It included fifty patients with L4-L5 lumbar degenerative spondylolisthesis (LDS), treated with decompression, pedicle screw, and rod instrumentation, along with posterolateral fusion (PLF), with or without transforaminal lumbar interbody fusion (TLIF). The patients were divided into two groups of 25 each (Group A: PLF only, Group B: PLF with TLIF). Intraoperative parameters were recorded, and outcomes were assessed using the visual analogue scale (VAS), Oswestry Disability Index (ODI), subjective satisfaction, radiologic union, and loss of reduction. Results were analyzed using SPSS software,

version 26. **Result:** The study compared two patient groups for spinal surgery outcomes (mean age, 52.4±14.1 years; follow-up, 54.1±13.8 months). Baseline demographics and preoperative clinical scores were comparable between groups ( $p>0.05$ ). TLIF significantly increased operative time ( $142.8 \pm 21.5$  vs.  $110.6 \pm 18.2$  min;  $p<0.001$ ) and blood loss ( $320.7 \pm 68.3$  vs.  $230.4 \pm 55.1$  mL;  $p<0.001$ ). At 12 months, both groups showed significant improvement in VAS and ODI scores, with no significant intergroup difference ( $p>0.05$ ). Patient satisfaction was similar (PLF 72% vs. PLF+TLIF 80%,  $p=0.49$ ). Radiologically, complete fusion was higher in the TLIF group (72% vs. 60%,  $p=0.21$ ), with minimal loss of reduction; cage subsidence occurred in 12% of TLIF cases. **Conclusion:** In the surgical management of patients with L4-L5 lumbar degenerative spondylolisthesis (LDS), the use of interbody fusion cages may not lead to significant improvements in radiological and clinical outcomes. Additionally, these cages might be linked to an increased risk of complications and morbidity.

**Keywords:** Lumbar spine, spondylolisthesis, and interbody fusion cage.

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## INTRODUCTION

Degenerative lumbar spondylolisthesis (DLS) is a common cause of back and leg pain in older adults, caused by vertebral slippage from disc and facet degeneration [1]. Lumbar degenerative spondylolisthesis (LDS) involves the slippage of a lumbar vertebra, typically less than 30–40%, to avoid severe neurological symptoms. Its global prevalence ranges from 5–7% in the general population, with a higher incidence observed in women and individuals over 50 years of age, particularly at the L4–L5 levels [2,3]. Low back pain, a common symptom of DLS, affects approximately 18–20% of the population [4]. There is an ongoing debate about the optimal operative strategy for DLS. Randomized trials and large comparative studies have shown that decompression alone can provide meaningful clinical improvement for many

patients, while the addition of instrumented fusion may reduce reoperation rates in selected cases but does not consistently produce superior short-term functional outcomes for all patients. Patient selection, such as grade of slip, instability, axial back pain, and multilevel disease, therefore, remains central to the decision whether to add fusion to decompression [5,6]. When fusion is performed, interbody cages such as TLIF/PLIF/ALIF/OLIF/LLIF are commonly used to restore disc height, increase foraminal area, and promote fusion. Cages can improve radiographic parameters, disc height, and segmental lordosis and are associated with high overall fusion rates, but they introduce device-specific risks such as subsidence, migration, and endplate-related collapse complications that can negatively affect both radiological alignment and clinical

outcomes. Cage design, size, material, insertion approach, and vertebral bone quality all influence fusion success and subsidence risk [7,8]. DLS is influenced by several key risk factors. Age is a significant determinant, with the condition becoming more prevalent in individuals over 50 years due to age-related degenerative changes in the spine [9]. Gender also plays a role; women, particularly postmenopausal, are at higher risk, possibly due to hormonal changes affecting ligamentous stability [10]. Anatomical factors such as sagittal orientation of the facet joints and facet joint asymmetry (tropism) contribute to spinal instability and are associated with an increased risk of DLS [11]. Genetic predisposition is also a factor, as a family history of spondylolisthesis or related spinal disorders can elevate risk [12]. Surgical intervention is indicated in

patients with persistent pain, neurological deficits, or significant functional impairment. Common surgical strategies include decompression alone or decompression with instrumented fusion. Fusion techniques, such as posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF), or lateral approaches (LLIF/OLIF), are used to restore spinal stability, maintain disc height, and improve foraminal dimensions. Interbody fusion cages enhance fusion rates and segmental alignment but carry risks including subsidence, migration, and adjacent segment degeneration. Patient selection, surgical approach, cage type, and bone quality are critical factors influencing outcomes [5-7]. This study aimed to evaluate the clinical and radiological outcomes of surgical management for lumbar degenerative spondylolisthesis, with a focus on the impact of interbody fusion cages on spinal alignment, fusion rates, and postoperative complications.

METHODS & MATERIALS

This prospective, comparative study was conducted in the Department of Orthopaedics in Holy Family Red Crescent Medical College Hospital, Dhaka, Bangladesh from January 2024 to December 2024. The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from all participants prior to enrollment. The study adhered to the principles outlined in the Declaration of Helsinki. A total of **50 consecutive patients** with single-level L4–L5 degenerative lumbar spondylolisthesis were enrolled.

**Study Groups:** Patients were assigned to two equal groups (n = 25 each):

- **Group A:** Posterolateral fusion (PLF) alone

- **Group B:** PLF combined with transforaminal lumbar interbody fusion (TLIF) using an interbody cage

All procedures were performed by two senior spine surgeons following standardized surgical protocols.

Inclusion criteria:

- Age 18–75 years
- Single-level degenerative lumbar spondylolisthesis (Grade I or II, Meyerding classification)
- Persistent low back pain, leg pain, or neurogenic claudication despite ≥6 months of conservative treatment

Exclusion criteria:

- Multi-level spondylolisthesis
- Previous lumbar spine surgery
- Osteoporosis (T-score < -2.5)
- Spinal deformity (scoliosis >20°)
- Active infection or malignancy
- Significant medical comorbidities precluding surgery

Surgical Technique

Patients were positioned prone under general anesthesia. In **Group A**, PLF was achieved using pedicle screw instrumentation and autologous bone graft along the posterolateral gutters. In **Group B**, TLIF was performed via a unilateral facetectomy and transforaminal corridor; an interbody cage packed with autologous bone graft was inserted, followed by pedicle screw fixation. Wound closure and hemostasis were meticulously performed in all cases.

Outcome Measures

Clinical outcomes were evaluated using the Visual Analog Scale (VAS) for back and leg pain and the Oswestry Disability Index (ODI) preoperatively and at 12 months postoperatively. Patient satisfaction was

assessed at final follow-up using a 4-point Likert scale (excellent, good, fair, poor). Radiological outcomes were assessed on standard anteroposterior and lateral radiographs and computed tomography at 12 months postoperatively. Fusion status was graded according to the Bridwell classification: Grade I (complete), Grade II (partial), and Grade III (non-union). Cage subsidence and loss of reduction were also documented.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency (percentage). Comparisons between groups were performed using Student’s t-test for normally distributed continuous variables and the Mann–Whitney U test for non-parametric data. Categorical variables were analyzed using chi-square or Fisher’s exact test, as appropriate. A two-tailed P-value <0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 26 (IBM Corp., Armonk, NY, USA).

RESULT

A total of 50 patients were enrolled and equally divided into Group A (PLF, n=25) and Group B (PLF + TLIF, n=25). Both groups were comparable at baseline with no statistically significant differences across age (51.8±13.9 vs. 52.9±14.4 years; p=0.78), gender distribution (male: 44.00% vs. 48.00%; p=0.64), and BMI (26.3±3.2 vs. 25.9±3.5 kg/m²; p=0.67). The duration of symptoms prior to surgery was similar between groups (16.2±5.7 vs. 17.0±6.1 months; p=0.58). Preoperative clinical severity based on VAS for back pain (7.1±1.0 vs. 7.3±0.9; p=0.42), VAS for leg pain (6.8±1.1 vs. 6.9±1.2; p=0.81), and ODI scores (52.4±7.8 vs. 53.1±8.2; p=0.74) also showed no significant differences (Table I).

**Table I**  
Baseline demographic and clinical characteristics of the study population (n=50).

| Variable                             | Group A<br>PLF (n=25) | Group B:<br>PLF + TLIF (n=25) | P-value |
|--------------------------------------|-----------------------|-------------------------------|---------|
| Age (years), mean ± SD               | 51.8 ± 13.9           | 52.9 ± 14.4                   | 0.78    |
| Gender, n (%)                        |                       |                               |         |
| Male                                 | 11 (44.00)            | 12 (48.00)                    | 0.64    |
| Female                               | 14 (56.00)            | 13 (52.00)                    |         |
| BMI (kg/m²), mean ± SD               | 26.3 ± 3.2            | 25.9 ± 3.5                    | 0.67    |
| Symptom duration (months), mean ± SD | 16.2 ± 5.7            | 17.0 ± 6.1                    | 0.58    |
| Preoperative VAS (back), mean ± SD   | 7.1 ± 1.0             | 7.3 ± 0.9                     | 0.42    |
| Preoperative VAS (leg), mean ± SD    | 6.8 ± 1.1             | 6.9 ± 1.2                     | 0.81    |
| Preoperative ODI (%), mean ± SD      | 52.4 ± 7.8            | 53.1 ± 8.2                    | 0.74    |

A significant difference was observed in operative time, which was longer in Group B (PLF + TLIF) compared to Group A (142.8±21.5 vs. 110.6±18.2 minutes; p<0.001). Estimated blood loss was also

significantly higher in Group B (320.7±68.3 mL) than in Group A (230.4±55.1 mL; p<0.001). Although blood transfusion was more frequent in Group B (20% vs. 8%), this difference was not

statistically significant (p=0.22). The mean hospital stay was slightly longer in Group B (5.9±1.4 vs. 5.4±1.2 days), but the difference was not significant (p=0.16) (Table II).

**Table II**  
Comparison of intraoperative parameters among the study population.

| Parameter                            | Group A<br>PLF (n=25) | Group B<br>PLF + TLIF (n=25) | P-value |
|--------------------------------------|-----------------------|------------------------------|---------|
| Operative time (minutes), mean ± SD  | 110.6 ± 18.2          | 142.8 ± 21.5                 | <0.001  |
| Estimated blood loss (mL), mean ± SD | 230.4 ± 55.1          | 320.7 ± 68.3                 | <0.001  |
| Blood transfusion, n (%)             | 2 (8.00)              | 5 (20.00)                    | 0.22    |
| Hospital stay (days), mean ± SD      | 5.4 ± 1.2             | 5.9 ± 1.4                    | 0.16    |

Both surgical groups showed substantial improvement in pain and disability at 12 months In *Table III*. The mean VAS score for back pain was 2.5±0.7 in Group A and 2.2±0.6 in Group B (p=0.18), while VAS

for leg pain was 2.3±0.8 vs. 2.1±0.7 (p=0.37), respectively. ODI scores also improved significantly in both groups, with no significant difference between them (18.6±5.1 vs. 17.9±4.8; p=0.58). Patient

satisfaction was high in both groups, with 72% of Group A and 80% of Group B reporting excellent or good outcomes (p=0.49).

**Table III**  
Postoperative functional outcomes at 12-month follow-up.

| Outcome                                      | Group A<br>PLF (n=25) | Group B<br>PLF + TLIF (n=25) | P-value |
|----------------------------------------------|-----------------------|------------------------------|---------|
| VAS (back) at 12 months, mean ± SD           | 2.5 ± 0.7             | 2.2 ± 0.6                    | 0.18    |
| VAS (leg) at 12 months, mean ± SD            | 2.3 ± 0.8             | 2.1 ± 0.7                    | 0.37    |
| ODI at 12 months (%), mean ± SD              | 18.6 ± 5.1            | 17.9 ± 4.8                   | 0.58    |
| Patient satisfaction (excellent/good), n (%) | 18 (72.00)            | 20 (80.00)                   | 0.49    |

*Table IV* presented that at the 12-month follow-up, complete intervertebral fusion (Grade I) was achieved in 60.00% of patients in Group A and 72.00% in Group B, though the difference was not statistically significant (p=0.21). Partial

fusion (Grade II) occurred in 28.00% vs. 20.00%, while non-union (Grade III) was observed in 12.00% vs. 8.00% of patients in Group A and Group B, respectively. Mean loss of reduction was slightly higher in Group A (1.8±0.7 mm) than Group B

(1.5±0.6 mm), without statistical significance (p=0.14). Cage subsidence was reported only in Group B in 3 patients (12.00%), while no subsidence occurred in Group A.

**Table IV**  
Radiological outcomes and fusion status following surgery.

| Outcome                            | Group A<br>PLF (n=25) | Group B<br>PLF + TLIF (n=25) | P-value |
|------------------------------------|-----------------------|------------------------------|---------|
| Intervertebral fusion at 12 months |                       |                              |         |
| Complete (Grade I)                 | 15 (60.00)            | 18 (72.00)                   | 0.21    |
| Partial (Grade II)                 | 7 (28.00)             | 5 (20.00)                    |         |
| Non-union (Grade III)              | 3 (12.00)             | 2 (8.00)                     |         |
| Loss of reduction (mm)             |                       |                              |         |
| Mean ± SD                          | 1.8 ± 0.7             | 1.5 ± 0.6                    | 0.14    |
| Cage subsidence, n (%)             | –                     | 3 (12.00)                    | –       |

**DISCUSSION**

Lumbar degenerative spondylolisthesis, one of the most frequent causes of spinal instability in adults, can manifest in a variety of forms, each of which plays a critical role in determining the optimal surgical management strategy and guiding the selection of appropriate interbody fusion techniques [13]. In this study, both surgical groups—PLF (Group A) and PLF + TLIF (Group B)—were comparable at baseline with respect to key demographic and clinical parameters, including age, gender distribution, body mass index (BMI), duration of symptoms, Visual Analogue Scale (VAS) scores, and Oswestry Disability Index (ODI) (p > 0.05 for all). This baseline equivalence minimizes potential confounding and ensures that any observed postoperative differences can be attributed primarily to the surgical technique rather than underlying demographic or clinical disparities. Comparable findings have been

reported by Kelly et al., who underscored that maintaining equivalent baseline characteristics is essential for valid comparative analyses between PLF and TLIF cohorts [14]. Group B (PLF + TLIF) demonstrated significantly increased operative time (142.8 ± 21.5 min vs. 110.6 ± 18.2 min; p < 0.001) and blood loss (320.7 ± 68.3 mL vs. 230.4 ± 55.1 mL; p < 0.001) compared to Group A. Although blood transfusion and hospital stay were higher in Group B, they were statistically insignificant. This aligns with Omidi-Kashani et al., who reported that addition of an interbody cage increases surgical duration and blood loss without substantially affecting early recovery outcomes [7]. Similar observations were made by Chen et al. in their meta-analysis, noting higher intraoperative burden in interbody fusion [15]. Both groups showed significant postoperative improvement in back pain (VAS), leg pain, and disability (ODI), but there was no statistically

significant difference between PLF and PLF + TLIF (p > 0.05 for all outcomes). Patient satisfaction rates were also comparable (72% vs. 80%). These findings support previous conclusions by Kelly et al. and Levin et al., who found no superiority of TLIF over PLF in terms of pain relief and functional recovery despite added interbody support [14,16]. Radiologically, PLF + TLIF showed a higher complete fusion rate (72% vs. 60%), although the difference was not statistically significant (p = 0.21). Loss of reduction was marginally lower in Group B, while cage subsidence was observed only in Group B (12%). This reflects the findings of Zhang et al., who reported slightly higher fusion rates with TLIF but emphasized lack of significant clinical benefit [17]. Omidi-Kashani similarly found no significant radiological advantage of using interbody cages in degenerative spondylolisthesis [7]. However, studies such as Loubeyre et al. have suggested that

transforaminal lumbar interbody fusion (TLIF) may provide superior restoration of sagittal spinal alignment and foraminal height in carefully selected patient populations, potentially offering biomechanical and functional advantages over posterolateral fusion alone <sup>[18]</sup>.

### LIMITATIONS

This study has certain limitations. The relatively short follow-up period may not fully capture long-term fusion integrity and adjacent segment degeneration. Radiological assessment relied primarily on plain radiographs, which may be less sensitive than advanced imaging modalities. Additionally, despite standardized surgical techniques, inter-surgeon variability and the modest sample size may limit the generalizability of the findings.

### CONCLUSION

Both posterolateral fusion (PLF) alone and PLF combined with transforaminal lumbar interbody fusion (TLIF) provide significant improvement in pain, functional outcomes, and patient satisfaction at 12 months in patients with single-level L4–L5 degenerative lumbar spondylolisthesis. While TLIF resulted in longer operative time and greater blood loss, it was associated with a higher rate of complete intervertebral fusion and minimal loss of reduction, without significant differences in clinical outcomes compared with PLF alone. These findings suggest that the addition of an interbody fusion cage may enhance radiological fusion, but both approaches achieve comparable short-term functional recovery.

### FUNDING

No funding sources

### CONFLICT OF INTEREST

None declared

### ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

### REFERENCES

1. Arimbawa IB, Pranata CG, Daniati S, Putra MW, Savio SD, Artha IG, Ridia KG, Suyasa IK. Comparison between decompression alone and with additional fusion for degenerative lumbar spondylolisthesis: a systematic review and meta-analysis. *Spine Surgery and Related Research*. 2023 Jan 27;7(1):42-51.
2. Majid K, Fischgrund JS. Degenerative lumbar spondylolisthesis: trends in management. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*. 2008 Apr 1;16(4):208-15.
3. Jacobsen S, Sonne-Holm S, Røvsing H, Monrad H, Gebuhr P. Degenerative lumbar spondylolisthesis: an epidemiological perspective: the Copenhagen Osteoarthritis Study. *Spine*. 2007 Jan 1;32(1):120-5.
4. Kalichman L, Hunter DJ. Diagnosis and conservative management of degenerative lumbar spondylolisthesis. *European Spine Journal*. 2008 Mar;17(3):327-35.
5. Försth P, Ólafsson G, Carlsson T, Frost A, Borgström F, Fritzell P, Öhagen P, Michaëlsson K, Sandén B. A randomized, controlled trial of fusion surgery for lumbar spinal stenosis. *New England Journal of Medicine*. 2016 Apr 14;374(15):1413-23.
6. Austevoll IM, Hermansen E, Fagerland MW, Storheim K, Brox JI, Solberg T, Rekeland F, Franssen E, Weber C, Brisby H, Grundnes O. Decompression with or without fusion in degenerative lumbar spondylolisthesis. *New England Journal of Medicine*. 2021 Aug 5;385(6):526-38.
7. Omid-Kashani F, Jalilian R, Golhasani-Keshtan F. Effect of interbody fusion cage on clinical and radiological outcome of surgery in L4–L5 lumbar degenerative spondylolisthesis. *Journal of Spine Surgery*. 2018 Mar;4(1):109.
8. Parisien A, Wai EK, ElSayed MS, Frei H. Subsidence of spinal fusion cages: a systematic review. *International Journal of Spine Surgery*. 2022 Dec 1;16(6):1103-18.
9. Wang YX, Káplár Z, Deng M, Leung JC. Lumbar degenerative spondylolisthesis epidemiology: a systematic review with a focus on gender-specific and age-specific prevalence. *Journal of orthopaedic translation*. 2017 Oct 1;11:39-52.
10. DeVine JG, Schenk-Kisser JM, Skelly AC. Risk factors for degenerative spondylolisthesis: a systematic review. *Evidence-based spine-care journal*. 2012 May;3(02):25-34.
11. Wang Z, Tian Y, Li C, Li D, Ibrahim Y, Yuan S, Wang X, Tang J, Zhang S, Wang L, Liu X. Radiographic risk factors for degenerative lumbar spondylolisthesis: a comparison with healthy control subjects. *Frontiers in Surgery*. 2022 Oct 14;9:956696.
12. Zhang Z, Tantai M, Ma H, Yu S, Chen B, Lu Z. Analysis of Risk Factors for Lumbar Spondylolisthesis: A Logistic Regression Study. *World Neurosurgery*. 2025 May 1;197:123931.
13. Spiker WR, Goz V, Brodke DS. Lumbar interbody fusions for degenerative spondylolisthesis: review of techniques, indications, and outcomes. *Global spine journal*. 2019 Feb;9(1):77-84.
14. Kelly JP, Alcalá-Marquez C, Dawson JM, Mehdod AA, Pinto MR. Treatment of degenerative spondylolisthesis by instrumented posterolateral versus instrumented posterolateral with transforaminal lumbar interbody single-level fusion. *Journal of Spine Surgery*. 2019 Sep;5(3):351.
15. Chen YC, Zhang L, Li EN, Ding LX, Zhang GA, Hou Y, Yuan W. An updated meta-analysis of clinical outcomes comparing minimally invasive with open transforaminal lumbar interbody fusion in patients with degenerative lumbar diseases. *Medicine*. 2019 Oct 1;98(43):e17420.
16. Levin JM, Tanenbaum JE, Steinmetz MP, Mroz TE, Overley SC. Posterolateral fusion (PLF) versus transforaminal lumbar interbody fusion (TLIF) for spondylolisthesis: a systematic review and meta-analysis. *The Spine Journal*. 2018 Jun 1;18(6):1088-98.
17. Zhang BF, Ge CY, Zheng BL, Hao DJ. Transforaminal lumbar interbody fusion versus posterolateral fusion in degenerative lumbar spondylosis: a meta-analysis. *Medicine*. 2016 Oct 1;95(40):e4995.
18. Loubeyre J, Ferrero E, Jmal MM, Guigui P, Khalifé M. Surgical treatment of degenerative lumbar spondylolisthesis: effect of TLIF and slip reduction on sagittal alignment. *Orthopaedics & Traumatology: Surgery & Research*. 2023 Oct 1;109(6):103541.