Scientific Research Publishing

Open Journal of Orthopedics, 2026, 16(6), 323-336
https://www.scirp.org/journal/ojo
ISSN Online: 2164-3016
ISSN Print: 2164-3008

Clinical and Radiological Outcome of Local Autogenous Bone Grafting for Spondylolisthesis

Md. Hamidul Haque[1*], Md. Shahidul Islam Akon[2], Md. Shafiul Ezaz[1], Abdullah Al Mahmud[1], Md. Kamruzzaman[1], Md. Solaiman Hasan[1], Mohammad Ullah[1], Muktasid Al Mubin[1]

[1]Department of Orthopaedic Surgery, IBN Sina Medical College Hospital, Dhaka, Bangladesh
[2]Department of Orthopaedic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
Email: *drrasheddmc@gmail.com, shahidakon10@gmail.com, shafiulezaz@gmail.com, draalmahmud@gmail.com, dr.kamruzzaman2001@gmail.com, hsolaiman780@gmail.com, dr.muharun1986@gmail.com, almubin1049@gmail.com

How to cite this paper: Haque, M.H., Akon, M.S.I., Ezaz, M.S., Mahmud, A.A., Kamruzzaman, M., Hasan, M.S., Ullah, M. and Mubin, M. (2026) Clinical and Radiological Outcome of Local Autogenous Bone Grafting for Spondylolisthesis. *Open Journal of Orthopedics*, **16**, 323-336.
https://doi.org/10.4236/ojo.2026.166031

Received: May 23, 2026
Accepted: June 21, 2026
Published: June 24, 2026

Abstract

Background: Spondylolisthesis is a common spinal disorder characterized by anterior displacement of one vertebra over another, with a prevalence of 3% - 10% in the general population. Given ongoing debate regarding optimal graft choice in instrumented fusion, this study aimed to evaluate the clinical and radiological outcomes of lumbar spondylolisthesis treated with posterior decompression and pedicle screw-rod fixation using local autogenous bone graft. **Methods:** This retrospective study was conducted in the Department of Orthopaedic Surgery, IBN Sina Medical College Hospital, Dhaka, Bangladesh (April 2021-March 2025), including 45 consecutive patients with Meyerding grade I - III lumbar spondylolisthesis treated with posterior decompression and pedicle screw-rod fixation using local autogenous bone graft. Patients with incomplete follow-up were excluded. Outcomes were assessed at ≥12 months (up to 30 months) using VAS, ODI, radiological parameters, and Bridwell and Modified Lee's fusion grading, with standardized postoperative rehabilitation. **Results:** A total of 45 patients (mean age 51.1 ± 13.8 years; 48.9% male) were included. L4 - L5 involvement (55.6%) and Grade II spondylolisthesis (64.4%) were most common. Significant improvements were observed in VAS, ODI, slip percentage, slip angle, disc height, and foraminal height (all $p < 0.001$). Successful fusion (Bridwell Grade I - II) was achieved in 95.6% of patients, with definitive fusion in 80.0%. Postoperative complications occurred in 4 patients (8.9%), including adjacent segment disease, pseudarthrosis, and deep infection, with no neurological deficit, implant failure, or donor-site morbidity. **Conclusion:** Local autogenous bone graft with instrumented

fusion provides safe, effective, and reliable clinical and radiological outcomes in lumbar spondylolisthesis.

Keywords

Clinical Outcome, Radiological Outcome, Spondylolisthesis

1. Introduction

Spondylolisthesis constitutes a prevalent spinal disorder defined by the anterior slippage of one vertebral body relative to the subjacent vertebra [1]. Epidemiological data reveal an incidence of 3% to 10% within the general population [2]-[4], with isthmic spondylolisthesis occurring in 4% to 8% of adults and degenerative spondylolisthesis showing a higher prevalence, affecting approximately 19.1% of males and 25.0% of females [2] [5]. Degenerative and isthmic variants predominate, with overall incidence rising beyond 18% among adults undergoing imaging, and the condition is more common in females and older age groups, particularly over 60 years [2] [5]. Often accompanied by radiculopathy, symptoms substantially impair quality of life and daily functioning [6]-[8].

Severity assessment in clinical practice commonly employs the Meyerding classification, which stratifies slippage from grades I to V based on percentage vertebral displacement, facilitating standardized surgical decision-making and prognostic evaluation [9]. The L5-S1 segment represents the most frequent site, followed by L4-L5, with approximately 75% of cases classified as Meyerding grade I [9].

Conservative management is the first-line approach, with most patients improving through activity modification and physiotherapy aimed at pain relief and spinal stabilization [2]. However, surgical intervention becomes necessary in cases of conservative treatment failure, progressive neurological deficit, or significant instability, with the goal of neural decompression and stable arthrodesis, often with instrumentation [6] [10]. Low-grade slips may be managed with motion-preserving or limited fusion techniques, while more severe or unstable cases require instrumented fusion procedures [10].

In surgical management, graft selection plays a pivotal role in achieving solid fusion. Local bone grafts harvested during decompression have shown outcomes comparable to interbody cages in terms of fusion rates and functional recovery, while avoiding donor-site morbidity associated with iliac crest harvesting [7] [11]. Autogenous grafts provide osteoconductive, osteoinductive, and osteogenic properties superior to allografts and synthetic substitutes, contributing to reliable fusion [12]. Compared with iliac crest grafts, local autografts derived from laminectomy and facetectomy sites offer similar biological advantages without additional morbidity, making them cost-effective and practical, especially in resource-limited settings [13].

Traditional fusion techniques such as PLIF, TLIF, and PLF are widely used, but

local autograft techniques reduce complications associated with cages, including migration, subsidence, and hardware failure, while maintaining comparable or superior fusion outcomes [11] [13]. They are particularly effective in single-level, low-grade spondylolisthesis, where they achieve solid arthrodesis comparable to iliac crest grafts without donor-site complications [14] [15]. For example, transforaminal lumbar interbody fusion using only local bone graft has demonstrated favorable clinical and radiological outcomes with low complication rates in single-level disease [4].

Despite these advantages, further evaluation of outcomes using local autogenous bone graft in instrumented fusion is warranted to establish its effectiveness in routine clinical practice. Therefore, this study aimed to evaluate the clinical and radiological outcomes of lumbar spondylolisthesis treated with posterior decompression and pedicle screw-rod fixation using local autogenous bone graft.

2. Objective

To evaluate the clinical and radiological outcomes of lumbar spondylolisthesis treated with decompression and instrumented fusion using local autogenous bone graft.

3. Methodology & Materials

This retrospective observational study was conducted in the Department of Orthopaedic Surgery, IBN Sina Medical College Hospital, Dhaka, Bangladesh. The study period extended from April 2021 to March 2025, and all eligible cases were reviewed retrospectively.

A total of consecutive patients who underwent surgery for lumbar spondylolisthesis during the study period were screened. After applying eligibility criteria, 45 patients were included in the final analysis. Patients excluded from the study included those with incomplete follow-up data or missing radiological/clinical records.

Ethical approval for this retrospective study was obtained from the Institutional Review Committee of IBN Sina Medical College Hospital. As this was a chart-based retrospective study, informed consent was waived in accordance with institutional policy.

3.1. Patient Population and Etiology

The study included patients with lumbar spondylolisthesis of degenerative and/or isthmic origin, confirmed through clinical evaluation and radiological imaging (plain radiographs and CT scans). The diagnosis of etiology was based on radiological features such as pars interarticularis defect (isthmic type) or degenerative facet/disc changes (degenerative type). The majority of cases were degenerative in nature.

All patients were classified according to the Meyerding grading system (Grade I - III).

3.2. Inclusion Criteria

- Patients were included if they had:
- Clinically and radiologically confirmed lumbar spondylolisthesis;
- Underwent posterior decompression with pedicle screw-rod fixation using local autogenous bone graft;
- Meyerding grade I - III spondylolisthesis;
- Complete preoperative and follow-up clinical and radiological records.

3.3. Exclusion Criteria

- Patients were excluded if they had:
- Conservative (non-surgical) management;
- Spondylolisthesis associated with other spinal pathologies (e.g., disc prolapse at adjacent levels or infection);
- Active spinal infection (e.g., spondylodiscitis);
- Severe comorbid conditions precluding surgery;
- Incomplete follow-up data.

3.4. Data Collection and Follow-Up

Data were extracted retrospectively from hospital records using a structured data collection sheet. Variables included demographic details, symptom duration, clinical presentation, operative details, and postoperative outcomes.

Preoperative evaluation included clinical examination and imaging with plain radiographs and CT scans. Radiological parameters included affected spinal level (L3-L4, L4-L5, L5-S1, or multi-level involvement) and severity grading using the Meyerding classification.

Patients were followed for up to 30 months, with a minimum follow-up of 12 months. Final outcome analysis was based on the last available follow-up for each patient.

3.5. Outcome Measures

3.5.1. Clinical Outcomes

Visual Analogue Scale (VAS) for pain;

Oswestry Disability Index (ODI) for functional disability.

3.5.2. Radiological Outcomes

Vertebral slip percentage and correction;

Slip angle;

Disc height;

Foraminal height;

Meyerding grade distribution.

3.5.3. Fusion Assessment

Fusion was assessed using:

Bridwell fusion criteria (primary outcome);

Modified Lee's criteria (secondary outcome);

Fusion outcomes were also analyzed according to preoperative Meyerding grade.

3.6. Surgical Technique

All patients underwent posterior decompression followed by pedicle screw-rod fixation under general anesthesia in the prone position. Local autogenous bone graft was harvested from laminectomy and facetectomy sites, morselized, and placed for posterolateral fusion. No iliac crest bone graft or interbody cage was used.

3.7. Postoperative Care and Follow-Up Protocol

Patients were mobilized early with brace support and physiotherapy. Hospital discharge typically occurred within a few days. Regular follow-up visits were conducted to evaluate clinical recovery, radiological alignment, and fusion status.

3.8. Statistical Analysis

Data were analyzed using appropriate statistical methods. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Pre- and post-operative comparisons were performed using paired statistical tests. A p-value < 0.05 was considered statistically significant.

4. Results

Table 1. Baseline demographic and clinical characteristics of the study population (n = 45).

Variable	Value
Mean age (years)	51.1 ± 13.8
Age range (years)	25 - 80
Male, n (%)	22 (48.9%)
Female, n (%)	23 (51.1%)
Mean duration of symptoms (years)	10.1 ± 5.9
Median follow-up duration (months)	30 (range 12 - 60)
Mean postoperative hospital stay (days)	3.8 ± 0.7
Single-level fusion, n (%)	40 (88.9%)
Multi-level fusion, n (%)	5 (11.1%)

The study included 45 patients with a mean age of 51.1 ± 13.8 years (range 25 - 80 years) and an almost equal sex distribution (48.9% male, 51.1% female). The mean duration of symptoms was 10.1 ± 5.9 years. The median follow-up duration was 30 months (range 12 - 60 months). The mean postoperative hospital stay was 3.8 ± 0.7 days. Most patients underwent single-level fusion (88.9%), while 11.1% required multi-level fusion (Table 1).

Table 2. Distribution of spondylolisthesis according to level and meyerding grade (n = 45).

Variable		Number (n)	Percentage (%)
Affected level	L3-L4	2	4.4%
	L4-L5	25	55.6%
	L5-S1	14	31.1%
	Multi-level involvement	4	8.9%
Preoperative meyerding grading	Grade I	10	22.2%
	Grade II	29	64.4%
	Grade III	6	13.3%

The L4-L5 level was the most commonly affected segment (25 patients, 55.6%), followed by L5-S1 (14 patients, 31.1%), L3-L4 (2 patients, 4.4%), and multi-level involvement (4 patients, 8.9%). According to Meyerding grading, Grade II spondylolisthesis was most frequent (29 patients, 64.4%), followed by Grade I (10 patients, 22.2%) and Grade III (6 patients, 13.3%) (Table 2).

Table 3. Clinical outcomes based on VAS and ODI scores (n = 45).

Outcome Measure	Preoperative (Mean ± SD)	Final Follow-Up (Mean ± SD)	Mean Improvement	p-Value
VAS score (0 - 10)	8.2 ± 1.1	1.6 ± 0.8	6.6	<0.001
ODI (%)	49.1 ± 8.4	16.3 ± 6.8	32.8	<0.001

There was a marked improvement in clinical outcomes following surgery. The mean VAS score improved from 8.2 ± 1.1 preoperatively to 1.6 ± 0.8 at final follow-up, with a mean improvement of 6.6 points ($p < 0.001$). Similarly, the mean ODI score decreased from 49.1 ± 8.4 to 16.3 ± 6.8, with a mean improvement of 32.8% ($p < 0.001$) (Table 3).

Table 4. Slip percentage improvement after surgery (n = 45).

Parameter	Preoperative (Mean ± SD)	Final Follow-Up (Mean ± SD)	Mean Improvement	p-Value
VAS score (0 - 10)	8.2 ± 1.1	1.6 ± 0.8	6.6	<0.001
ODI (%)	49.1 ± 8.4	16.3 ± 6.8	32.8	<0.001

Radiological assessment demonstrated a significant reduction in slip percentage from 33.1 ± 8.2% preoperatively to 12.2 ± 4.5% at final follow-up, corresponding to a mean improvement of 20.9 ± 5.8% ($p < 0.001$). Overall slip improvement was 63.1 ± 11.8% (Table 4).

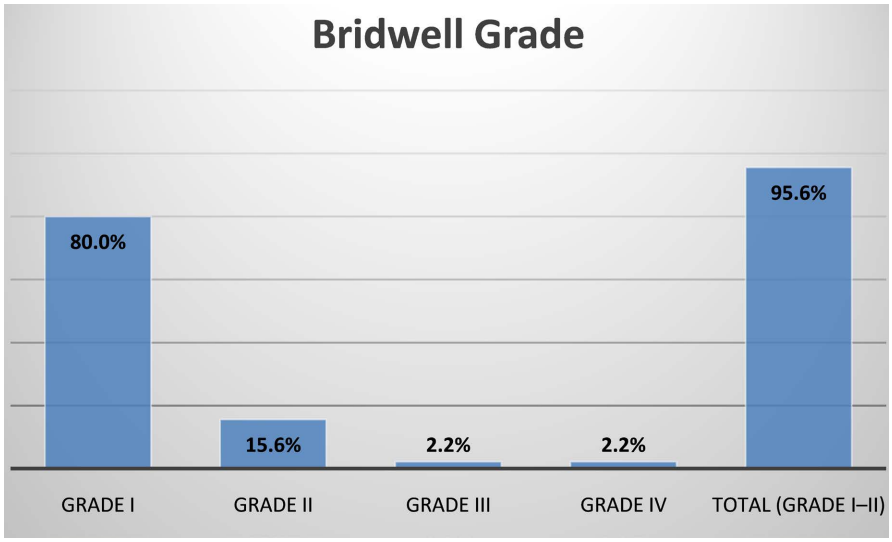

Figure 1. Fusion outcome according to Bridwell radiological criteria (n = 45).

Successful fusion was achieved in the majority of patients. Grade I fusion was observed in 36 patients (80.0%), Grade II in 7 patients (15.6%), Grade III in 1 patient (2.2%), and Grade IV in 1 patient (2.2%). Overall successful fusion (Grade I - II) was achieved in 43 patients (95.6%) (Figure 1).

Table 5. Fusion outcome according to Modified Lee's criteria (n = 45).

Fusion Status	Number (n)	Percentage (%)
Definitive fusion	36	80.0%
Possible fusion	7	15.6%
Pseudoarthrosis/Failed fusion	2	4.4%

According to Modified Lee's criteria, definitive fusion was achieved in 36 patients (80.0%), possible fusion in 7 patients (15.6%), and pseudoarthrosis or failed fusion in 2 patients (4.4%) (Table 5).

Table 6. Fusion rate stratified by preoperative meyerding grade (n = 45).

Preoperative Grade	Number of Patients	Successful Fusion (Bridwell I - II), n	Fusion Rate (%)
Grade I	10	10	100.0%
Grade II	29	27	93.1%
Grade III	6	6	100.0%

Fusion rates were highest in Grade I and Grade III spondylolisthesis (100% each), while Grade II patients demonstrated a slightly lower fusion rate of 93.1% (27 out of 29 patients) (Table 6).

Table 7. Radiological changes in spinal alignment and disc parameters (n = 45).

Parameter	Preoperative (Mean ± SD)	Final Follow-Up (Mean ± SD)	Mean Improvement	p-Value
Slip angle (˚)	18.9 ± 4.1	9.6 ± 2.9	9.3 ± 3.0	<0.001
Disc height (mm)	6.4 ± 1.3	9.3 ± 1.1	2.9 ± 1.0	<0.001
Foraminal height (mm)	13.6 ± 2.1	16.5 ± 1.8	2.9 ± 1.1	<0.001

Significant postoperative improvements were observed in all radiological parameters. Slip angle decreased from 18.9 ± 4.1˚ to 9.6 ± 2.9˚, disc height increased from 6.4 ± 1.3 mm to 9.3 ± 1.1 mm, and foraminal height improved from 13.6 ± 2.1 mm to 16.5 ± 1.8 mm (all $p < 0.001$) (Table 7).

Table 8. Postoperative complications (n = 45).

Complication	Number (n)	Percentage (%)
Adjacent segment disease	2	4.4%
Pseudarthrosis	2	4.4%
Neurological deficit	0	0.0%
Deep infection	1	2.2%
Implant failure	0	0.0%
Donor site morbidity	0	0.0%

Postoperative complications occurred in 4 patients (8.9%). Adjacent segment disease and pseudarthrosis were observed in 2 patients each (4.4%), while deep infection occurred in 1 patient (2.2%). One patient experienced both pseudarthrosis and deep infection (Table 8). No cases of neurological deficit, implant failure, or donor-site morbidity were observed.

5. Discussion

In this retrospective observational study conducted at the Department of Orthopaedic Surgery, IBN Sina Medical College Hospital, Dhaka, 45 patients with lumbar spondylolisthesis treated with posterior decompression and pedicle screw-rod fixation using local autogenous bone graft were evaluated for clinical and radiological outcomes. Most patients presented with degenerative, low- to moderate-grade disease, predominantly involving the L4-L5 level, with significant baseline pain and functional disability. Postoperative assessment demonstrated marked improvement in VAS and ODI scores, substantial reduction in slip parameters, and high rates of radiological fusion with minimal complications, indicating favorable clinical and radiological outcomes following local autograft-based instrumented fusion.

The baseline demographic and clinical profile of the present cohort is consistent

with previously published studies on lumbar spondylolisthesis treated with pedicle screw fixation and local autogenous bone graft. The mean age of 51.1 ± 13.8 years (range 25 - 80 years) reflects the typical middle-aged to elderly population seen in degenerative spondylolisthesis, where progressive segmental instability and disc degeneration predominate. Similar findings have been reported by Lee *et al.* [16] and Tattari *et al.* [17], who also noted a predominance of middle-aged adults, L4-L5 involvement, and single-level fusion in most cases. In the present study, the long symptom duration and high proportion of single-level fusion (88.9%) further support a chronic, localized disease pattern. The median follow-up duration of 30 months (12 - 60 months) and short postoperative hospital stay reflect adequate long-term assessment and contemporary perioperative care. Overall, the similarity of baseline characteristics with prior literature supports the external validity of this cohort and strengthens interpretation of the clinical and radiological outcomes.

The distribution of spondylolisthesis levels and preoperative Meyerding grades in the present study is consistent with previously reported patterns in patients undergoing instrumented fusion with local autogenous bone grafting. In our cohort, L4-L5 was the most frequently affected level (55.6%), followed by L5-S1 (31.1%), while L3-L4 involvement and multi-level disease were comparatively uncommon. Similarly, Grade II spondylolisthesis was the predominant preoperative severity (64.4%), with fewer patients presenting with Grade I (22.2%) and Grade III (13.3%) slips. These findings closely align with the results reported by Yang *et al.* [7], who demonstrated that degenerative spondylolisthesis treated with posterior transforaminal lumbar interbody fusion using local autogenous morselized bone graft most commonly involves the L4-L5 level, followed by L5-S1, reflecting the biomechanical vulnerability of the lower lumbar segments. They also observed a predominance of low-grade (Meyerding Grade I-II) slips, with Grade II being the most frequent, which is in agreement with the present study. Overall, this consistency supports the well-established understanding that degenerative spondylolisthesis predominantly affects the L4-L5 segment and usually presents as low-grade instability, making it amenable to decompression and instrumented fusion with local autograft.

The present study demonstrated a marked and statistically significant improvement in clinical outcomes following lumbar decompression and instrumented fusion using local autogenous bone graft for spondylolisthesis. The mean VAS score improved from 8.2 ± 1.1 preoperatively to 1.6 ± 0.8 at final follow-up, while ODI decreased from 49.1 ± 8.4% to 16.3 ± 6.8%, reflecting substantial pain relief and functional restoration. These findings are consistent with previously published studies evaluating similar surgical techniques. Rayhan *et al.* [3] reported comparable results in patients with low-grade lumbar spondylolisthesis treated with decompression, pedicle screw fixation, and local bone grafting, where VAS improved from approximately 7 - 8 preoperatively to around 2 postoperatively, and ODI decreased from about 55 - 60% to 15 - 20%, along with favorable fusion out-

comes. Similarly, Subramanian *et al.* [18] demonstrated significant clinical benefit following pedicle screw-assisted interbody fusion, with VAS reduction from 7 - 8 to nearly 2 and ODI improvement from approximately 60% to 18%, highlighting the effectiveness of stable segmental fixation in restoring spinal alignment and relieving neural compression. The consistency of these findings with the present study reinforces that local autogenous bone grafting combined with instrumented fusion provides reliable pain relief and functional improvement in degenerative spondylolisthesis, with outcomes comparable to established surgical series.

The present study demonstrated a significant radiological correction of vertebral slip following decompression and instrumented fusion using local autogenous bone graft for spondylolisthesis. The mean slip percentage improved from 33.1 ± 8.2% preoperatively to 12.2 ± 4.5% at final follow-up, corresponding to a mean reduction of 20.9 ± 5.8% and an overall slip improvement of 63.1 ± 11.8%, indicating sustained restoration of sagittal alignment. These findings are consistent with previously reported outcomes in the literature. Hagenmaier *et al.* [19] demonstrated that instrumented lumbar fusion leads to a significant reduction in vertebral slip from approximately 25% preoperatively to 15 - 17% postoperatively, with maintenance of correction over long-term follow-up, highlighting the stability achieved with posterior instrumentation. Similarly, Isogai *et al.* [20] reported a progressive reduction in slip percentage from a mean of about 21% preoperatively to 11% after interbody fusion and further improvement to approximately 4% following pedicle screw fixation, achieving an overall correction rate of nearly 80%, with sustained alignment at follow-up. The comparable magnitude of correction observed in the present study reinforces that rigid posterior fixation combined with fusion using local autogenous bone graft effectively restores and maintains vertebral alignment in degenerative spondylolisthesis.

The present study demonstrated a high rate of radiological fusion following posterior decompression and instrumented fixation with local autogenous bone graft for spondylolisthesis, as assessed by the Bridwell grading system. Grade I fusion was achieved in 80.0% of patients, Grade II in 15.6%, while only a small proportion exhibited Grade III (2.2%) and Grade IV (2.2%) outcomes, resulting in an overall successful fusion rate (Grade I - II) of 95.6%. These findings are consistent with previously published evidence. Zhao *et al.* [21], using the same Bridwell criteria, reported successful fusion (Grade I - II) in approximately 85 - 95% of patients, with Grade I being the most frequent outcome and higher-grade nonunion (Grade III - IV) occurring in less than 10% of cases. The close agreement between the present study and Zhao *et al.* [21] reinforces the reliability of pedicle screw-assisted fusion in achieving solid arthrodesis, particularly when supplemented with local autogenous bone graft harvested during decompression.

The fusion outcomes using Modified Lee's criteria further demonstrate a high rate of successful arthrodesis. In the present study, definitive fusion was achieved in 80.0% of patients, with an additional 15.6% showing possible fusion, while pseudoarthrosis or failed fusion was observed in only 4.4% of cases. These find-

ings are consistent with Rao *et al.* [22], who reported a combined definitive and probable fusion rate of approximately 91.7%, with pseudoarthrosis occurring in a small minority of cases (~8%). Similarly, Sleem *et al.* [4] observed that the majority of patients undergoing instrumented fusion for degenerative spondylolisthesis achieved solid fusion, with only a limited proportion showing possible fusion and rare pseudoarthrosis. Collectively, these studies reinforce that local autogenous bone grafting combined with rigid posterior instrumentation yields reliably high fusion rates, with most patients achieving definitive or near-definitive radiological union.

The stratified fusion outcomes according to preoperative Meyerding grade demonstrate uniformly high fusion success across all grades of spondylolisthesis. Grade I and Grade III patients achieved a 100% fusion rate, while Grade II patients demonstrated a slightly lower but still excellent fusion rate of 93.1%. These findings are in close agreement with Bydon *et al.* [23], who reported overall solid fusion rates of approximately 91 - 92%, with near-complete union in lower-grade slips and persistently high fusion success even in higher-grade cases when rigid fixation was used. This reinforces that when stable posterior instrumentation is achieved, preoperative slip grade has minimal influence on final fusion outcome.

The present study demonstrates significant postoperative radiological improvement in spinal alignment and disc space parameters following decompression and pedicle screw fixation with local autogenous bone grafting. There was a marked reduction in slip angle from 18.9 ± 4.1˚ to 9.6 ± 2.9˚, along with significant increases in disc height (6.4 ± 1.3 mm to 9.3 ± 1.1 mm) and foraminal height (13.6 ± 2.1 mm to 16.5 ± 1.8 mm), with all changes reaching statistical significance ($p < 0.001$). These findings closely align with Abou-Madawi *et al.* [14], who similarly reported significant postoperative restoration of slip percentage, disc height, segmental alignment, and foraminal dimensions following instrumented fusion. Furthermore, a recent systematic review and meta-analysis by Tavares *et al.* [24], including 64 studies comparing graft types in lumbar fusion, demonstrated that local bone graft achieved the highest fusion proportion (~95%), exceeding iliac crest autograft (~88%) and allograft groups. The consistency across studies highlights the biomechanical effectiveness of posterior stabilization with local autograft in restoring disc space height and achieving reliable fusion outcomes.

The complication profile in the present study demonstrates a relatively low overall morbidity following surgery. Adjacent segment disease and pseudarthrosis were each observed in 4.4% of patients, while deep infection occurred in 2.2%. One patient experienced both pseudarthrosis and deep infection. Importantly, no neurological deficits, implant failures, or donor site morbidity were observed. These findings are consistent with Booth *et al.* [25], who similarly reported very low complication rates following instrumented lumbar fusion, with rare pseudarthrosis, low infection rates, and negligible neurological complications. Overall, the comparable safety profile supports the use of local autograft as a reliable and low-morbidity option in instrumented fusion for degenerative spondylolisthesis.

6. Limitations of the Study

The study had a few limitations:

- Small sample size (n = 45), which may limit the statistical power and generalizability of the findings.
- Single-center study, which may limit external validity across different populations and surgical settings.

7. Conclusion

Lumbar spondylolisthesis is a common degenerative spinal condition that often requires surgical stabilization when symptoms and instability progress. In this study, decompression with instrumented fusion using local autogenous bone graft demonstrated excellent clinical and radiological outcomes, with marked improvement in pain and functional status after surgery. Radiological assessment showed significant correction of deformity and restoration of spinal alignment, along with improved disc and foraminal dimensions. High rates of solid fusion were achieved across all grades of spondylolisthesis, indicating reliable arthrodesis with this technique. Overall, complication rates were low and no major neurological or implant-related adverse events were observed. These findings suggest that local autogenous bone graft is an effective and safe option for achieving durable clinical recovery and stable fusion in the management of lumbar spondylolisthesis.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Goyal, D.K.C., Tarazona, D.A., Segar, A., Sutton, R., Motto, M.A., Divi, S.N., *et al.* (2021) Lumbar Pedicle Morphology and Vertebral Dimensions in Isthmic and Degenerative Spondylolisthesis—A Comparative Study. *International Journal of Spine Surgery*, **15**, 243-250. https://doi.org/10.14444/8009

[2] Mohile, N.V., Kuczmarski, A.S., Lee, D., Warburton, C., Rakoczy, K. and Butler, A.J. (2022) Spondylolysis and Isthmic Spondylolisthesis: A Guide to Diagnosis and Management. *The Journal of the American Board of Family Medicine*, **35**, 1204-1216. https://doi.org/10.3122/jabfm.2022.220130r1

[3] Rayhan, M.F., Rezwan, M. and Sarker, M.M. (2022) Study on Lumbar Interbody Fusion and Posterior Instrumentation in Spondylolisthesis. *MOJ Orthopedics & Rheumatology*, **14**, 158-161. https://doi.org/10.15406/mojor.2022.14.00598

[4] Sleem, A. and Marzouk, A. (2018) Transforaminal Lumbar Interbody Fusion with Local Bone Graft Alone for Single-Level Isthmic Spondylolisthesis. *International Journal of Spine Surgery*, **12**, 70-75.

[5] Akkawi, I. and Zmerly, H. (2022) Degenerative Spondylolisthesis: A Narrative Review. *Acta Bio Medica*: *Atenei Parmensis*, **92**, e2021313.

[6] Kunze, K.N., Lilly, D.T., Khan, J.M., Louie, P.K., Ferguson, J., Basques, B.A., *et al.* (2020) High-Grade Spondylolisthesis in Adults: Current Concepts in Evaluation and Management. *International Journal of Spine Surgery*, **14**, 327-340. https://doi.org/10.14444/7044

[7] Yang, J., Yang, Y., Wang, G., Xu, S., Li, G., Zhang, S., *et al.* (2023) Is Local Autogenous Morselized Bone Harvested from Decompression through a Posterior-Transforaminal Approach Sufficient for Single-Level Interbody Fusion in the Lower Lumbar Spine? *BMC Musculoskeletal Disorders*, **24**, Article No. 12. https://doi.org/10.1186/s12891-023-06131-4

[8] Yang, X., Wang, D., He, Y., Yan, L., Hao, D. and He, B. (2020) Quantification Evaluation of Structural Autograft versus Morcellized Fragments Autograft in Patients Who Underwent Single-Level Lumbar Laminectomy. *Experimental and Therapeutic Medicine*, **20**, 1803-1807. https://doi.org/10.3892/etm.2020.8831

[9] Li, N., Scofield, J., Mangham, P., Cooper, J., Sherman, W. and Kaye, A.D. (2022) Spondylolisthesis. *Orthopedic Reviews*, **14**, Article No. 36917. https://doi.org/10.52965/001c.36917

[10] Kalhoro, A., Ahmed, K. and Hashim, A.S. (2024) The Operative Efficacy of Decompression and Fixation Surgery for Degenerative Lumbosacral Spondylolisthesis: A Single Institutional Study. *Journal of Postgraduate Medical Institute*, **38**, 192-197. https://doi.org/10.54079/jpmi.38.3.3358

[11] Liu, Z., Liu, J., Tan, Y., He, L., Long, X., Yang, D., *et al.* (2014) A Comparative Study between Local Bone Graft with a Cage and with No Cage in Single Posterior Lumbar Interbody Fusion (PLIF): A Multicenter Study. *Archives of Orthopaedic and Trauma Surgery*, **134**, 1051-1057. https://doi.org/10.1007/s00402-014-2016-6

[12] Khan, S.N. and Shahzad, H. (2023) Osteobiologics and Value-Based Care: Challenges and Opportunities. *International Journal of Spine Surgery*, **17**, S44-S52. https://doi.org/10.14444/8560

[13] D'Souza, M., Macdonald, N.A., Gendreau, J.L., Duddleston, P.J., Feng, A.Y. and Ho, A.L. (2019) Graft Materials and Biologics for Spinal Interbody Fusion. *Biomedicines*, **7**, Article 75. https://doi.org/10.3390/biomedicines7040075

[14] Abou-Madawi, A.M., Ali, S.H. and Abdelmonem, A.M. (2022) Local Autograft versus Iliac Crest Bone Graft PSF-Augmented TLIF in Low-Grade Isthmic and Degenerative Lumbar Spondylolisthesis. *Global Spine Journal*, **12**, 70-78. https://doi.org/10.1177/2192568220946319

[15] Aimar, E., Di Stefano, L., Longhitano, F., Bona, A., Meloni, M., Alfiero, T., *et al.* (2026) Does Adding an Interbody Cage in L4-L5 Posterolateral Fusion for Degenerative Spondylolisthesis and Stenosis Improve Clinical Outcome? *Brain and Spine*, **6**, Article 105926. https://doi.org/10.1016/j.bas.2026.105926

[16] Lee, S.C., Chen, J.F., Wu, C.T. and Lee, S.T. (2009) *In Situ* Local Autograft for Instrumented Lower Lumbar or Lumbosacral Posterolateral Fusion. *Journal of Clinical Neuroscience*, **16**, 37-43. https://doi.org/10.1016/j.jocn.2008.02.009

[17] Tattari, B.P., Nimmagadda, V.V. and Tapadar, J.I. (2017) A Prospective Study on Surgical Management of Lumbar Spondylolisthesis with Pedicle Screw Fixation and Posterolateral Fusion. *International Journal of Research in Orthopaedics*, **3**, Article 1113. https://doi.org/10.18203/issn.2455-4510.intjresorthop20174698

[18] Subramanian, K., Prabu, G.R., Kalyanasundaram, K. and Hariharan, D. (2023) Degenerative Lumbar Spondylolisthesis Treated with Lumbar Interbody Fusion with Cage and Pedicle Screw Fixation—A Prospective Study. *International Journal of Academic Medicine and Pharmacy*, **5**, 765-769.

[19] Hagenmaier, H.F., Delawi, D., Verschoor, N., Oner, F.C. and van Susante, J.L. (2013) No Correlation between Slip Reduction in Low-Grade Spondylolisthesis or Change in Neuroforaminal Morphology and Clinical Outcome. *BMC Musculoskeletal Disorders*, **14**, Article No. 245. https://doi.org/10.1186/1471-2474-14-245

[20] Isogai, N., Yoshida, K., Shiono, Y., Sasao, Y., Funao, H. and Ishii, K. (2022) Respective Correction Rates of Lateral Lumbar Interbody Fusion and Percutaneous Pedicle Screw Fixation for Lumbar Degenerative Spondylolisthesis. *Medicina*, **58**, Article 169. https://doi.org/10.3390/medicina58020169

[21] Zhao, W., Zhou, C., Zhang, H., Guo, J., Han, J., Lin, A., *et al.* (2023) Clinical, Radiographic and Fusion Comparison of Oblique Lumbar Interbody Fusion (OLIF) Stand-Alone and OLIF with Posterior Pedicle Screw Fixation in Patients with Degenerative Spondylolisthesis. *BMC Musculoskeletal Disorders*, **24**, Article No. 852. https://doi.org/10.1186/s12891-023-06985-8

[22] Rao, G.P., Azeez, D.M.Q.A. and Kumar, S.A. (2018) Evaluation of the Clinico-Radiological Outcome of Lumbar Interbody Fusion Using Cage and Local Bone Graft in Management of Lumbar Spondylolisthesis. *International Journal of Orthopaedics Sciences*, **4**, 814-822. https://doi.org/10.22271/ortho.2018.v4.i4k.103

[23] Bydon, A., Dasenbrock, H.H. and Suk, I. (2012) Posterior Lumbar Fusion by Open Technique. In: Quiñones-Hinojosa, A., Ed., *Schmidek and Sweet Operative Neurosurgical Techniques*, Elsevier, 1899-1930. https://doi.org/10.1016/b978-1-4160-6839-6.10166-2

[24] Tavares, W.M., de França, S.A., Paiva, W.S. and Teixeira, M.J. (2022) A Systematic Review and Meta-Analysis of Fusion Rate Enhancements and Bone Graft Options for Spine Surgery. *Scientific Reports*, **12**, Article No. 7546. https://doi.org/10.1038/s41598-022-11551-8

[25] Booth, K.C., Bridwell, K.H., Eisenberg, B.A., Baldus, C.R. and Lenke, L.G. (1999) Minimum 5-Year Results of Degenerative Spondylolisthesis Treated with Decompression and Instrumented Posterior Fusion. *Spine*, **24**, Article 1721. https://doi.org/10.1097/00007632-199908150-00014