ORIGINAL ARTICLE

Clinical Outcomes of Posterior Lumbar Interbody Fusion for the Management of Clinical and Radiological Instability: A Six-Month Retrospective Analysis at a Tertiary Care Hospital

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Abstract

Background: Lumbar instability is a common and debilitating condition, which is associated with chronic low back pain and significant functional impairment. Posterior lumbar interbody fusion (PLIF) is an invasive surgical procedure that involves simultaneous nerve decompression and spinal stabilization.

Objectives: To assess clinical and radiological outcomes of PLIF in the management of lumbar instability.

Methods: A retrospective study was performed in adult patients undergoing PLIF between November 2025 and April 2026. Pain intensity was assessed using the Visual Analogue Scale (VAS), disability with the Oswestry Disability Index (ODI) and quality of life with the SF-36 Health Survey. Radiological outcomes were assessed using plain CT scan and MRI at baseline, and at three and six months postoperatively.

Results: 43 patients were included in the inclusion criteria (mean age 44.3 ±13.6 years; 54.8% male), and degenerative disc disease was the diagnosis of choice (57%). Significant improvements were observed in VAS (7.6 ±1.3 to 2.1 ± 0.9; $p < 0.001$), ODI scores (57.8 ±10.5% to 21.9 ±6.8%; $p<0.001$), and SF-36 Physical Component Summary (33.2 ±7.8 to 49.5 ± 7.3; $p < 0.001$). Satisfactory spinal fusion was confirmed in 92.9% of patients at six months, and the overall complication rate was 9.5%, with no significant neurological deficits or implant failures.

Conclusion: PLIF is a safe, effective and reproducible surgical approach for lumbar instability with noticeable improvement in pain, function, and quality of life as well as high radiological fusion rates and a favorable risk of complications.

Keywords: Lumbar instability, PLIF; spinal fusion, low back pain, ODI, Visual Analogue Scale, SF-36.

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INTRODUCTION:

Lumbar instability is characterized by abnormal spinal segments that cause pain, neurological dysfunction, and progressive impairment. The worldwide burden of low back pain attributed to lumbar degenerative diseases is increasing, and elective lumbar fusion procedures have skyrocketed over the past two decades. [1] Lumbar instability is defined by degenerative disc disease, spondylolisthesis, chronic disc herniation, and post-traumatic instability. Surgery may be required to address each of these conditions. Spinal fusion surgery has been done since the year 1911, when Albee and Hibbs independently described the first surgical procedures for posterior spinal arthrodesis.[2] Since then, there have been multiple types of fusion performed, including posterolateral fusion (PLF), anterior lumbar interbody fusion (ALIF), transforaminal lumbar interbody fusion (TLIF), and posterior lumbar interbody fusion (PLIF).[3] Of these, PLIF and TLIF are most frequently performed because they can support the interbody and decompress the nerve in a single approach.[3,4]

Briggs and Milligan described PLIF in 1943, and Cloward refined the technique in 1953.[5] The technique allows us to see right into the brain and restore the height of the intervertebral disc, arthrodesis around the base of the spine, and anterior column stability without tearing the posterior ligamentous complex.[6,7] Biomechanically, the anterior interbody graft absorbs approximately 80% of the compressive axial load, reducing the stress on the posterior pedicle screws.[8,9] But there are still some complications with PLIF, including paraspinal muscle fatigue from prolonged bilateral retraction, epidural bleeding and difficulty restoring lumbar lordosis.[10]

TLIF was developed by Harms and Rolinger in 1982 to overcome some limitations of PLIF through a unilateral transforaminal corridor.[10,11] Although TLIF decreases bilateral nerve root manipulation, there has not been a clear-cut comparison of the relative advantages of PLIF or TLIF when it comes to fusion rates, clinical outcomes, or complication rates.[12–18] The choice between PLIF or TLIF is contingent upon the surgeon’s experience, patient anatomy, and the specific pathology. [4]

In Pakistan, the quality of surgical care and postoperative monitoring of complex spinal pathologies in neurosurgical centers is often constrained by the shortage of resources. Insufficient outcomes data are reported from tertiary care centers in this region. The aim of this study was to evaluate the short-term clinical and radiological effects of PLIF in patients with confirmed lumbar instability treated at a single tertiary care neurosurgical center in Peshawar.

METHODS

Study Design, Setting, and Duration

This study was a single-centre retrospective observational study at the Neurosurgery Department of Khyber Teaching Hospital, Peshawar, KPK, Pakistan. All patients who underwent consecutive PLIF in the period 1st November 2025 - 30 April 2026 were included. The research was conducted in compliance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist for observational research. Ethical approval [ref no: 334/DME/KMC] was received on 5th May 2025 by the Institutional Review Board of Khyber Medical College and Khyber Teaching Hospital, Peshawar and informed Every patient gave their consent at the first visit.

Study Population Selection Criteria

Those 18 years or older with clinically and radiologically confirmed lumbar instability who underwent PLIF at the time of the study (sectional instability on dynamic (flexion/extension) radiographs, narrowing in the disc space, changes in the endplate, or spondylolisthesis on MRI or CT were eligible. Complete perioperative medical records, including preoperative assessments and at least six months postoperative follow-up data, were required. Patients who had incomplete medical records or no available follow up reports were excluded they were diagnosed with spinal cancer or an infection, or they had significant comorbidities (uncontrolled diabetes mellitus, severe cardiopulmonary disease, or active autoimmune diseases) that could influence the outcome of surgery.

Operative Procedure

All surgeries were carried out under general anesthesia with the patient lying prone on a Wilson frame. Posterior midline incision and bilateral subperiosteal muscle dissection were performed. After laminectomy or laminotomy and medial facetectomy, the nerve roots were carefully pulled back to reveal the intervertebral disc. Following discectomy, endplate preparation was performed, and autogenous local bone graft supplemented with synthetic bone substitute was packed into the interbody space prior to cage insertion. Pedicle screw fixation was completed at the affected level(s) with fluoroscopic guidance. Wound closure was performed in layers with a suction drain left in situ for 24–48 hours.

Outcome Measures

Patient evaluation was performed at three distinct chronological intervals: preoperatively (baseline), followed by prospective clinical follow-ups at 3 months and 6 months postoperatively. The therapeutic efficacy of the procedure was analyzed through several distinct clinical dimensions. Pain severity was documented using the 0–10 Visual Analog Scale (VAS), allowing for separate, targeted tracking of radicular leg pain and axial back pain [25]. Functional limitations and physical disability secondary to lumbar pathology were quantified using the Oswestry Disability Index (ODI), expressed as a percentage score [25]. Finally, overall patient well-being and health-related quality of life were captured via the SF-36 Health Survey, which was broken down into its distinct Physical Component Summary (PCS) and Mental Component Summary (MCS) domains to observe both physical rehabilitation and psychological recovery trends [26].

As a baseline assessment, radiographic examination included anteroposterior and lateral lumbar spine radiographs (with dynamic views taken at the 6-month follow-up), CT imaging for detection of spinal fusion, and MRI for brain decompression. There was no visible movement on the CT flexion-extension radiographs, and no radiolucent areas around the implanted hardware. All post-operative complications were recorded in the patient's chart and retrieved retrospectively from the chart.

Data Analysis

IBM SPSS Statistics version 26.0 was used to analyze the data. Continuous variables such as age, symptom scores, and clinical variables were reported as mean ±standard deviation (SD) when a normal distribution was observed, or median with interquartile range (IQR) when the distribution was not normal. Data normality was tested with the Shapiro–Wilk test. Variables such as sex, co-morbid conditions, and baseline clinical characteristics were reported as counts and percentages.

For comparing preoperative to postoperative measures, we used the paired Student's t-test for normally distributed variables, and the Wilcoxon signed-rank test for nonparametric data. Two-sided p-values of 0.05 were considered significant.

RESULTS:

Patient Demographics and Clinical Data

43 patients were included in the inclusion criteria and were included in the final analysis. The mean age was 44.3 ± 13.6 years (range 15–65 years), with the majority falling in the 31–50-year age group (45.2%). Male patients predominated slightly (54.8%). Degenerative disc disease was the most common indication for surgery (57.1%), followed by spondylolisthesis grade I–II (23.8%), recurrent disc herniation (11.9%), and traumatic instability (7.1%). Single-level fusion was performed in 34 patients (81.0%), predominantly at L4–L5 (50.0%) and L5–S1 (38.1%). Full demographic and clinical characteristics are summarized in Table 1.

Table 1. Preoperative Profile of Patients Undergoing PLIF

Characteristic	Value
Mean age (years) ± SD	44.3 ± 13.6
Age range (years)	15–65
Age 15–30 years, n (%)	8 (19.0%)
Age 31–50 years, n (%)	19 (45.2%)
Age 51–65 years, n (%)	15 (35.7%)
Male sex, n (%)	23 (54.8%)
Female sex, n (%)	19 (45.2%)
Degenerative disc disease, n (%)	24 (57.1%)
Spondylolisthesis (grade I–II), n (%)	10 (23.8%)

Characteristic	Value
Recurrent disc herniation, n (%)	5 (11.9%)
Traumatic instability, n (%)	3 (7.1%)
Single-level fusion, n (%)	34 (81.0%)
Two-level fusion, n (%)	8 (19.0%)
Fusion level L4–L5, n (%)	21 (50.0%)
Fusion level L5–S1, n (%)	16 (38.1%)
Fusion level L3–L4, n (%)	3 (7.1%)
Two-level L4–S1, n (%)	2 (4.8%)

Clinical Outcomes

Statistically significant improvements were observed in all clinical outcome measures following PLIF. The mean VAS score for back pain decreased from 7.6 ± 1.3 preoperatively to 3.7 ± 1.1 at three months and further to 2.1 ± 0.9 at six months, representing a 72.4% reduction ($p < 0.001$). The ODI improved from 57.8 ± 10.5% preoperatively to 33.6 ± 8.9% at three months and 21.9 ± 6.8% at six months, reflecting a 62.1% improvement in functional capacity ($p < 0.001$). The SF-36 PCS increased from 33.2 ± 7.8 to 49.5 ± 7.3 ($p < 0.001$), and the MCS improved from 44.5 ± 9.2 to 52.8 ± 7.1 ($p = 0.005$). These results are presented in Table 2.

Table 2. Clinical Outcomes – Pain, Disability, and Quality of Life at Preoperative, 3-Month, and 6-Month Follow-Up (n = 42)

Outcome Measure	Preoperative	3 Months	6 Months	p-value
VAS (back pain)	7.6 ± 1.3	3.7 ± 1.1	2.1 ± 0.9	<0.001
ODI (%)	57.8 ± 10.5	33.6 ± 8.9	21.9 ± 6.8	<0.001
SF-36 PCS	33.2 ± 7.8	42.1 ± 8.0	49.5 ± 7.3	<0.001
SF-36 MCS	44.5 ± 9.2	48.3 ± 8.5	52.8 ± 7.1	0.005

VAS = Visual Analog Scale; ODI = Oswestry Disability Index; PCS = Physical Component Summary; MCS = Mental Component Summary. Paired t-test comparing 6-month versus preoperative values.

Radiological Outcomes

39 patients (92.9%) had good bony fusion confirmed by CT at the six-month follow-up, 37 patients had maintained their intervertebral height (88.1%), and 40 patients (95.2%) had correct implant position without any indication of malposition. Two patients had mild to moderate adjacent segment degeneration (4.8%). There was more than 2mm subsidence on the graft (1.4%), and one patient had hardware loosening (2.4%). Table 3 reports the findings.

Table 3. Radiological Outcomes at 6-Month Follow-Up (n = 42)

Radiological Parameter	n (%)
Satisfactory fusion (bridging bone on CT)	39 (92.9%)
Maintenance of intervertebral height	37 (88.1%)
Proper implant positioning (no malposition)	40 (95.2%)
Adjacent segment degeneration (mild–moderate)	2 (4.8%)
Graft subsidence >2 mm	1 (2.4%)
Hardware loosening	1 (2.4%)

Postoperative Complications

Overall, 9 % (4 of 42 patients) experienced a complication (4 of 42). Two patients (4.8%) contracted a superficial wound infection requiring conservative antibiotic therapy. One patient (2.4%) experienced brief postoperative radiculopathy that resolved spontaneously without intervention. One patient had an incidental durotomy (3.4%) during the operative procedure, which was treated conservatively, and there was no loss of cerebrospinal fluid. One patient (2.4%) experienced superficial wound dehiscence. There were no cases of severe neurological deficit, deep surgical site infection, implant failure or revision surgery during the follow-up period. Table 4 lists all the complications.

Table 4. Postoperative Complications Within the 6-Month Follow-Up Period (n = 42)

Complication	n (%)
Minor wound infection (managed conservatively)	2 (4.8%)
Transient postoperative radiculopathy	1 (2.4%)
Dural tear (intraoperative, primarily repaired)	1 (2.4%)
Superficial wound dehiscence	1 (2.4%)
Implant failure / revision surgery required	0 (0.0%)
Major neurological deficit	0 (0.0%)
Deep surgical site infection	0 (0.0%)
Total patients with ≥1 complication	4 (9.5%)

Pre- versus Post-operative Comparison

A formal comparison of preoperative and six-month postoperative outcome measures is presented in Table 5. All three primary outcome parameters demonstrated highly significant improvements, confirming the consistency and clinical relevance of the observed benefit.

Table 5. Comparison of Preoperative and 6-Month Postoperative Outcomes (n = 42)

Parameter	Preoperative	6 Months	Mean Difference (95% CI)	p
VAS (pain)	7.6 ± 1.3	2.1 ± 0.9	−5.5 (−6.0, −5.0)	<0.001
ODI (%)	57.8 ± 10.5	21.9 ± 6.8	−35.9 (−40.3, −31.5)	<0.001
SF-36 PCS	33.2 ± 7.8	49.5 ± 7.3	+16.3 (+13.4, +19.2)	<0.001

CI = confidence interval; PCS = Physical Component Summary. All comparisons were performed using paired Student's T-test.

DISCUSSION:

The findings of this study demonstrate that PLIF is a clinically effective and radiologically reliable procedure for the management of lumbar instability in a tertiary care setting. The marked reduction in VAS scores (72.4% at six months) and the substantial improvement in ODI (62.1%) are consistent with outcomes reported in the international literature, corroborating the analgesic and rehabilitative efficacy of this procedure.[7,11,18,19] The SF-36 data further indicate that the benefits of PLIF extend beyond pain relief to encompass global health-related quality of life, including psychological wellbeing, an outcome that is increasingly recognized as central to the evaluation of spine surgery success.[20]

The 92.9% radiological fusion rate observed in this group was similar to or higher than the rates reported from systematic reviews and meta-analyses of PLIF and TLIF outcomes. [3,4,20] Success in fusion depends on an endplate prepared carefully, graft material selected accurately, strong pedicle screw retention, and patient compliance with postoperative physiotherapy. The high rate of implant placement (95.2%) indicates the importance of fluoroscopic intraoperative guidance and experienced surgical technique. [6]

Overall, in the present series, complications were 9.5%, an improvement over previously reported rates ranging from 10% to 25% in open PLIF. [13,14,18] Major neurological deficits, deep infections, or revisions were not observed following this procedure, reflecting patient selection, aseptic management, and early identification of complications, such as dural tears. One incidental durotomy was also performed without sequelae consistent with the current evidence for primary dural repair. [13,14,18]

The relative merits of PLIF versus TLIF are still debated in the literature. [4,9,16,17] TLIF has the advantage of decreasing the extent of bilateral nerve root retraction and less epidural scarring. In contrast, PLIF allows a more complete view of the spinal canal and allows bilateral decompression in the central canal stenosis. We show that with the right patient and surgeon, PLIF can produce results at least as good as TLIF, and it is therefore worth a place in the surgical arsenal for lumbar instability. [4,20]

Several limitations of this study are to be noted. The retrospective single-centre design may bias selection and hinder generalizability. The six-month follow-up interval may have captured early clinical and radiologic outcomes, but it is insufficient to assess long-term fusion, adjacent segment disease, or implant life. Without a control or comparator arm, we cannot conclude with certainty that PLIF is superior to other surgical options. Further, a relatively small sample size may not have produced the power to detect rare complications. Future multicenter randomized controlled trials (MCRSEMPTRCTs) or prospective register studies with longer follow-up are needed.

CONCLUSION:

Posterior lumbar interbody fusion is a safe, effective, and reproducible surgical option for treatment of lumbar instability. In this retrospective analysis, PLIF was associated with significantly lower pain intensity, disability, and health-related quality of life, a higher rate of radiological fusion, and fewer overall complications. These results provide good support for the continuing use of PLIF in selected patients with clinical and radiological lumbar instability provided that the procedure is performed in a specialized centre with equipment and surgeons.

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