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*Original Article*

# Therapeutic efficacy of endoscopic lumbar interbody fusion in patients with lumbar instability and analysis of prognostic factors

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**Abstract:** Objective: To evaluate the therapeutic efficacy of endoscopic lumbar interbody fusion (ELIF) in the management of lumbar instability and identify potential prognostic factors. Methods: A retrospective analysis was conducted on 278 patients treated for lumbar instability at Baoji Hospital of Traditional Chinese Medicine between February 2021 and November 2023. Based on treatment approach, the patients were divided into two arms: ELIF group (n=141) and posterior lumbar interbody fusion (PLIF) group (n=137). Comparisons were conducted across multiple clinical metrics including operation time, intraoperative hemorrhage volume, duration of postoperative hospitalization, and functional-pain-related assessments such as VAS (visual analogue scale), ODI (Oswestry Disability Index), and JOA (Japanese Orthopedic Association) scores. Additional imaging outcomes (e.g., lumbar lordosis, degree of spondylolisthesis, and dural cross-sectional area) were also evaluated. JOA improvement over a 12-month period was the primary follow-up indicator. Multivariate logistic regression analysis was employed to identify prognostic risk factors. Results: ELIF was associated with significantly reduced surgical duration, less intraoperative blood loss, and faster postoperative recovery (P<0.05). Postoperatively, ELIF patients exhibited significantly lower VAS and ODI scores and higher JOA score (P<0.05). Radiographic improvements in sagittal balance (lumbar lordosis), vertebral alignment (spondylolisthesis), and neural decompression (dural area) were more pronounced in the ELIF group (P<0.05). One year post-surgery, the JOA score improvement in the ELIF group remained superior. However, advanced age (≥60 years), diabetes, severe preoperative spondylolisthesis (≥ grade II), and baseline JOA <10 were independently associated with suboptimal outcomes. Conclusion: ELIF is an effective approach for treating lumbar instability, offering advantages in efficiency, functional recovery, and postoperative rehabilitation. Identifying key prognostic factors may refine clinical decision-making and optimize perioperative strategies for improved outcomes.

**Keywords:** Lumbar instability, endoscopic lumbar interbody fusion (ELIF), posterior lumbar interbody fusion (PLIF), prognostic evaluation, risk stratification

## Introduction

Lumbar spinal instability typically results from disrupted biomechanics in the lumbar segment, often triggered by degenerative disc alterations, lax supporting ligaments, or vertebral translation. Such pathological alterations facilitate irregular intersegmental motion and vertebral misalignment [1], gradually compromising the integrity of the spinal axis. Clinically, these mechanical abnormalities manifest as chronic low back pain, radicular symptoms in the lower limbs, reduced flexibility, and unstable gait patterns. In severe cases, nerve root or spinal cord compression can occur, leading to numbness, muscle weakness, abnormal reflexes, lower limb weakness, or urinary incontinence - symptoms that substantially impair patients' quality of life and daily functioning [2].

When lumbar instability is diagnosed, doctors have to decide between conservative treatment and surgery. The choice isn't always straightforward and depends on the severity of the condition, the patient's age and overall health, and the preoperative scan images. Conservative treatments are typically the first approach and may include medication, physical therapy, back brace, or lifestyle modifications. However, if these methods fail to provide adequate relief or

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if the condition worsens, surgical intervention may be necessary [3]. For a long time, Posterior Lumbar Interbody Fusion (PLIF) has been a standard surgical option. In this operation, the surgeon makes an open incision to remove damaged disc tissue, followed by the insertion of bone grafts or internal hardware (e.g., screws and rods) to promote vertebral fusion [4]. However, this approach comes with significant drawbacks, including large incisions, risk of substantial blood loss, and prolonged recovery periods. Moreover, complications such as infection, nerve damage, or bone fusion failure, are notable concerns, particularly in elderly patients or those with comorbidities.

Recent advances in spinal surgery have introduced a less invasive alternative: Endoscopic Lumbar Interbody Fusion (ELIF). This procedure works through a small incision, using a guided endoscope to clear the disc space, stabilize the vertebrae, and prompt fusion, all with minimal damage to the surrounding soft tissue. Compared to PLIF, studies suggest ELIF offers several advantages, including reduced surgical trauma, less bleeding, faster recovery, and shorter hospital stays [5, 6]. Moreover, postoperative safety data and complication rates also appear to favor ELIF [7].

This study aims to compare ELIF and PLIF in treating lumbar instability. Our goal is to evaluate the effectiveness of each procedure and, specifically for ELIF, to identify factors that may predict optimal patient outcomes.

## Materials and methods

### *Sample size calculation*

Sample size calculation was based on a recent study by You et al. [8] comparing biportal endoscopic lumbar interbody fusion (a minimally invasive endoscopic technique) with traditional PLIF. Using intraoperative blood loss as the primary outcome, with an expected difference of 105 ml and a standard deviation of 100 ml, a two-sided t-test with $\alpha=0.05$ and power $(1-\beta)=0.80$ yielded a required sample size of approximately 71 patients per group. Accounting for a potential 20% loss to follow-up, we aimed to enroll approximately 85 patients per group.

### *Study participants*

This retrospective analysis included 278 patients with lumbar instability treated at Baoji Hospital of Traditional Chinese Medicine from February 2021 to November 2023. Patients were divided into two groups based on the treatment method: ELIF (n=141) and PLIF (n=137). The study was approved by the Ethics Committee of the Baoji Hospital of Traditional Chinese Medicine.

### *Inclusion and exclusion criteria*

*Inclusion criteria:* 1. Diagnosis of lumbar instability confirmed by imaging studies (X-ray, CT, MRI). 2. Presence of clinically significant symptoms refractory to conservative treatment, meeting surgical indications. 3. Age between 18 and 80 years, with sufficient physical condition to undergo surgery.

*Exclusion criteria:* 1. Presence of severe systemic diseases (e.g., heart, kidney, liver, or other organ failures). 2. Contraindications for surgery, such as spinal infections, severe osteoporosis, or fractures. 3. Inability to comply with follow-up or incomplete data preventing long-term postoperative evaluation. 4. History of severe neurological disorders (e.g., spinal cord injury or neurodegenerative diseases) that may affect surgical outcomes. 5. Pregnancy or lactation, or other conditions interfere with surgery or study participation. 6. Allergies to anesthetic agents or other contraindications to anesthesia.

### *Treatment protocol*

*ELIF:* Before undergoing ELIF, each patient underwent a comprehensive preoperative evaluation. The procedure was performed under general anesthesia with the patient positioned face down. A C-arm fluoroscope, a type of live X-ray, was used to precisely identify the location on the spine. A small incision, approximately 2 to 3 cm long, was made. The surgeon then used a series of dilators to gently separate the skin, muscles, and ligaments, creating a pathway to the space between the vertebrae. Guided by the endoscope, the surgeon moved the degenerated disc and damaged tissue. A bone graft or an artificial disc was placed to restore the natural disc height, and an internal device, such as a titanium cage, was implanted for spinal stability. After ensuring hemostasis, the incision was closed. Postoperatively, patients were hospitalized for one or two days, with a follow-up scheduled within a week to assess the fusion and monitor neurological recovery. Most patients resumed daily activities within two weeks, with significant functional improvement observed within three months.

*PLIF:* For the comparison group, traditional PLIF was performed. The setup was similar to ELIF: the procedure was performed under general anesthesia with patient positioned face down. However, PLIF procedure requires a larger incision, typically 5 to 8 cm, over the lower back. The layers of skin, fat, and muscle were dissected to expose the spine. To access the disc, a laminectomy (removal of a small portion of the lamina bone) or a small window in the bone was necessary. After removal of the degenerated disc, the disc space was carefully cleaned, ensuring protection of nearby nerves. A bone graft or artificial disc was then implanted, followed by insertion of internal hardware, such as screws and rods, to secure the vertebrae and restore stability. Throughout the operation, controlling bleeding and maintaining a clean surgical field were critical priorities. Postoperative care was more intensive compared to ELIF, with patients typically requiring a hospital stay of 3 to 5 days. Regular follow-up appointments were scheduled, and patients were encouraged to engage in a rehabilitation program. Functional recovery was monitored during follow-up visits at the 6-month and 1-year marks after the surgery.

### *Outcome measures*

*Surgical-related indicators:* (1) Surgical time: Total time from skin incision to final wound closure. (2) Intraoperative blood loss: Estimated blood loss during the procedure. (3) Postoperative hospital stay: Duration from surgery to discharge.

*Functional recovery evaluation:* Postoperative assessments included: (1) Visual analog scale (VAS), for evaluating postoperative pain (0= no pain, 10= worst pain) [9]. (2) Oswestry disability index (ODI), for assessing functional disability in daily activities (0= no disability, 100= total disability) [10]. (3) Japanese orthopedic association (JOA) score, for evaluating clinical functional recovery (0= worst, 29= best) [11].

*Radiological indicators:* (1) Lumbar spondylolisthesis, measured by X-ray or CT to determine the anteroposterior displacement of lumbar vertebrae. (2) Lumbar lordosis angle, assessed via X-ray to evaluate lumbar curvature. (3) Dural sac cross-sectional area, analyzed by MRI or CT to assess changes in the cross-sectional area of the dural sac.

### *Follow-up*

Patients were followed up for 1 year postoperatively, with assessments at 1 month, 3 months, 6 months, and 1 year. Prognosis was evaluated using the JOA score at 1 year post-surgery. A JOA improvement rate of ≥25% was defined as a good prognosis, whereas an improvement rate <25% indicated a poor prognosis [12].

### *Statistical methods*

Data were processed and analyzed using SPSS 26.0 statistical software. Continuous variables were expressed as mean ± standard deviation ($\overline{x}$ ± sd), with intergroup comparisons performed using independent samples t-test. For preoperative and postoperative comparisons within the same group, paired t-tests were used. Categorical variables were expressed as frequency and percentage (n, %) and compared between groups using the Chi-square test or Fisher's exact test. Multivariate logistic regression analysis was conducted to identify risk factors influencing the prognosis of patients undergoing ELIF surgery. A two-tailed *p*-value of <0.05 was considered statistically significant.

## Results

### *Comparison of general data between the ELIF and PLIF groups*

A total of 278 patients were included in this study, with an average age of 61.81±9.48 years. Of these, 147 were male and 131 were female. Diabetes was noted in 63 patients (22.7%), and hypertension was observed in 78 patients (28.1%). A total of 188 patients had Grade I lumbar spondylolisthesis, and 90 patients had Grade II lumbar spondylolisthesis. There were no significant differences between the ELIF and PLIF groups in terms of age, gender, diabetes, hypertension, or preoperative lumbar spondylolisthesis grade (P>0.05, **Table 1**). This indicates that the baseline characteristics were comparable between the two groups.

**Table 1.** Comparison of baseline data between the ELIF and PLIF groups

| Clinical indicators | | ELIF group (n=141) | PLIF group (n=137) | $t/x^2$ | *P* |
|---|---|---|---|---|---|
| Age (years) | | 62.30±9.08 | 61.33±9.88 | 0.854 | 0.394 |
| Gender (male/female) | | 72/69 | 75/62 | 0.378 | 0.539 |
| Comorbid diabetes (n, %) | | 30 (21.3%) | 33 (24.1%) | 0.313 | 0.576 |
| Comorbid hypertension (n, %) | | 38 (26.9%) | 40 (29.2%) | 0.174 | 0.677 |
| Preoperative lumbar spondylolisthesis degree (n, %) | Grade I | 98 (69.5%) | 90 (%65.7) | 0.461 | 0.497 |
| | Grade II | 43 (30.5%) | 47 (34.3%) | | |

Note: ELIF: Endoscopic Lumbar Interbody Fusion, PLIF: Posterior Lumbar Interbody Fusion.

**Table 2.** Comparison of surgical indicators between the ELIF and PLIF groups

| Clinical indicators | ELIF group (n=141) | PLIF group (n=137) | *t* | P |
|---|---|---|---|---|
| Surgical time (min) | 126.33±20.64 | 160.40±30.62 | -10.849 | <0.001 |
| Intraoperative blood loss (ml) | 69.30±15.21 | 127.31±27.73 | -21.541 | <0.001 |
| Postoperative hospital stay (days) | 6.38±1.16 | 8.32±2.01 | -9.812 | <0.001 |

Note: ELIF: Endoscopic Lumbar Intervertebral Disc Fusion, PLIF: Posterior Lumbar Intervertebral Disc Fusion.

*Comparison of surgical indicators between the ELIF and PLIF groups*

The ELIF group showed significantly shorter surgical times, reduced intraoperative blood loss, and a shorter hospital stay compared to the PLIF group (all P<0.05, **Table 2**).

*Comparison of postoperative functional recovery and radiological indicators between the ELIF and PLIF groups*

Preoperatively, no significant differences were observed between the two groups in terms of VAS, ODI, or JOA scores (P>0.05). However, at 6 months postoperatively, the ELIF group demonstrated lower VAS and ODI scores, but higher JOA scores compared to the PLIF group (P<0.05). Additionally, improvements in lumbar spondylolisthesis, lumbar lordosis angle, and the dural sac cross-sectional area were significantly greater in the ELIF group than in those the PLIF group (P<0.05). These results are detailed in **Table 3.**

*Comparison of JOA score improvement rate at 1 year postoperatively between the ELIF and PLIF groups*

At 1 year post-surgery, the ELIF group showed a significantly higher JOA score improvement rate than the PLIF group (P<0.05, **Figure 1**). In the ELIF group, 101 patients (71.6%) showed improvement in JOA scores, compared to 77 patients (56.2%) in the PLIF group.

*Univariate analysis of factors influencing the prognosis in patients undergoing ELIF*

Univariate analysis compared clinical factors between the good prognosis group (JOA score improvement rate ≥25%) and the poor prognosis group (JOA score improvement rate <25%). Significant differences were found between the two groups in terms of age, diabetes, preoperative JOA score, and lumbar spondylolisthesis grade (P<0.05). However, there were no significant differences in terms of gender, hypertension, lumbar lordosis angle, or dural sac cross-sectional area (P>0.05), as shown in **Table 4**.

*Multivariate logistic regression analysis of factors influencing the prognosis in patients undergoing ELIF*

Logistic regression analysis identified age ≥60 years, diabetes, preoperative lumbar spondylolisthesis grade ≥ II, and preoperative JOA score <10 as significant risk factors for poor prognosis in ELIF patients (P<0.05). These results are presented in **Table 5** and **Figure 2**.

*Preoperative and postoperative radiographic imaging findings*

Preoperative X-ray images showed significant L4/5 disc herniation with lumbar instability, showing disc herniation and abnormal spinal alignment, indicative of surgical intervention (**Figure 3A**). X-ray images taken at 12 months postoperatively showed a favorable outcome

**Table 3.** Comparison of postoperative functional recovery and radiological indicators between the ELIF and PLIF groups

| Clinical indicators | ELIF group (n=141) | | Statistic | *P* value | PLIF group (n=137) | | Statistic | *P* value |
|---|---|---|---|---|---|---|---|---|
| | Pre-operative | Post-operative | | | Pre-operative | Post-operative | | |
| VAS score | 7.42±1.23 | 2.35±0.97[a] | 40.91 | P<0.001 | 7.45±1.21 | 3.56±1.42 | 23.812 | P<0.001 |
| ODI score | 55.82±8.12 | 23.45±7.86[a] | 33.46 | P<0.001 | 56.01±8.24 | 33.21±9.11 | 21.286 | P<0.001 |
| JOA score | 12.48±3.05 | 22.16±3.88[a] | -23.301 | P<0.001 | 12.51±3.08 | 17.28±4.12 | -10.562 | P<0.001 |
| Lumbar spondylolisthesis degree (mm) | 4.15±1.12 | 2.12±0.96[a] | 15.852 | P<0.001 | 4.10±1.08 | 3.01±1.03 | 8.384 | P<0.001 |
| Lumbar lordosis angle (degrees) | 32.56±4.75 | 38.21±5.02[a] | -9.657 | P<0.001 | 32.59±4.84 | 35.42 ± 4.33 | -5.07 | P<0.001 |
| Dura matter cross-sectional area ($mm^2$) | 110.23±32.45 | 168.45±38.54[a] | -13.307 | P<0.001 | 112.14±34.21 | 135.64±36.21 | -5.599 | P<0.001 |

Note: Compared to the PLIF group postoperatively, [a]P<0.05; ELIF: Endoscopic Lumbar Intervertebral Disc Fusion, PLIF: Posterior Lumbar Intervertebral Disc Fusion, VAS: Visual Analogue Scale, ODI: Oswestry Disability Index, JOA: Japanese Orthopedic Association Score.

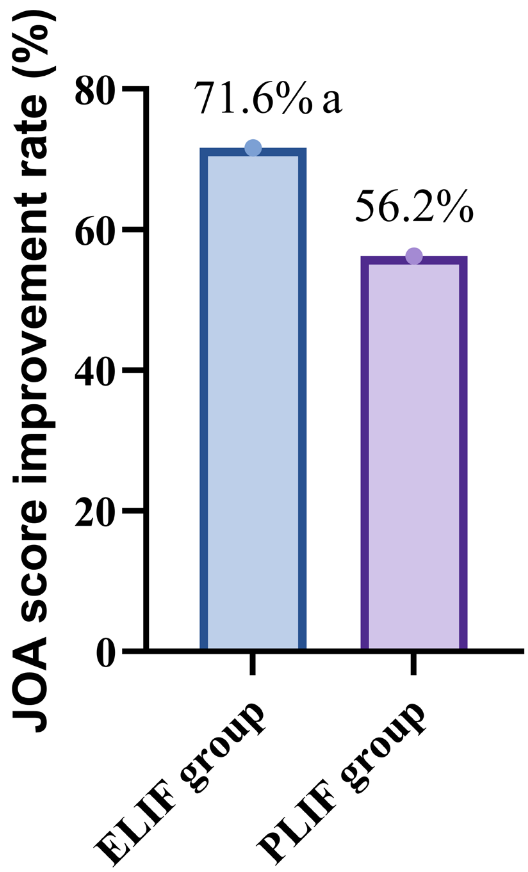


**Figure 1**. Comparison of JOA score improvement rate between the ELIF and PLIF groups at 1 year postoperatively. Note: Compared to the PLIF group postoperatively, [a]$P<0.05$; ELIF: Endoscopic Lumbar Intervertebral Disc Fusion, PLIF: Posterior Lumbar Intervertebral Disc Fusion, JOA: Japanese Orthopedic Association Score.

after ELIF. The intervertebral implants were successfully fused, the intervertebral height was well maintained, and the position of internal fixation was satisfactory. No complications such as pseudoarthrosis formation or malalignment were observed. The imaging confirmed that lumbar stability had been restored (**Figure 3B**).

## Discussion

Lumbar spine instability is a prevalent condition associated with chronic low back pain, radicular pain, and reduced mobility, significantly impairing patients' quality of life. With the aging population and increasing prevalence of degenerative lumbar diseases, the incidence of lumbar instability is rising, posing substantial challenges to both healthcare systems and society [13, 14]. Treatment for lumbar instability includes both conservative and surgical options. Conservative management is typically effective for milder cases, but surgical intervention is required when symptoms worsen, particularly in the presence of neurological impairment or significant deterioration in quality of life.

In recent years, ELIF has emerged as a promising minimally invasive surgical approach to treat lumbar instability. Compared to traditional open surgery, ELIF reduces surgical trauma, lowers the risk of postoperative complications, and improves surgical precision through endoscopic guidance. Increasing evidence suggests that ELIF can deliver clinical outcomes equivalent to those of PLIF, often with the additional benefits of quicker rehabilitation, more effective pain relief, and improved functional outcomes [15, 16]. However, despite the growing interest in ELIF, head-to-head clinical evaluations with PLIF remain relatively limited in the literature. Additionally, inconsistencies across current studies have left certain aspects of this comparison open to debate.

While PLIF has long been a standard approach for alleviating symptoms and stabilizing the lumbar spine, it is also associated with substantial surgical trauma, increased intraoperative bleeding, and extended recovery periods. In contrast, ELIF employs endoscopic access through a small incision, facilitates disc debridement and bone grafting with minimal tissue disruption [17, 18], resulting in reduced operative blood loss, shorter hospital stays, and a milder postoperative course. Indeed, earlier investigations have consistently demonstrated ELIF's superiority over traditional PLIF in limiting perioperative trauma, reducing recovery time, and lowering complication rates, especially with regard to intraoperative hemorrhage control and postoperative pain relief [19, 20]. These advantages not only contribute to enhanced quality of life for patients but also alleviate the economic and logistical burdens on healthcare systems.

In addition to its general surgical merits, ELIF has shown enhanced effectiveness in restoring spinal alignment, specifically in correcting

**Table 4.** Univariate analysis of factors influencing the prognosis in patients undergoing ELIF

| Factors | Good Prognosis Group (n=98) | Poor Prognosis Group (n=43) | $t/x^2$ | *P* |
|---|---|---|---|---|
| Age (years) | | | 4.412 | 0.036 |
| ≥60 | 45 (45.9%) | 28 (65.1%) | | |
| <60 | 53 (54.1%) | 15 (34.9%) | | |
| Gender (male/female) | 56/42 | 17/26 | 3.711 | 0.054 |
| Diabetes (n, %) | 19 (19.4%) | 15 (34.9%) | 3.922 | 0.048 |
| Hypertension (n, %) | 26 (26.5%) | 12 (27.9%) | 0.029 | 0.865 |
| Preoperative JOA score (points) | 13.50±2.58 | 9.30±2.20 | 9.878 | <0.001 |
| Lumbar spondylolisthesis degree (n, %) | | | 8.785 | 0.003 |
| Grade I | 71 (%) | 20 (%) | | |
| Grade II | 27 (%) | 23 (%) | | |
| Lumbar lordosis angle (degrees) | 32.22±4.22 | 31.08±4.28 | 1.470 | 0.146 |
| Dura matter cross-sectional area ($mm^2$) | 113.65±33.91 | 111.89±22.34 | 0.364 | 0.716 |

Note: JOA: Japanese Orthopedic Association Score.

**Table 5.** Multivariate logistic regression analysis of factors influencing the prognosis in patients undergoing ELIF

| Indicators | B | S.E. | Wald | *P* | OR | 95% CI for Exp (B) |
|---|---|---|---|---|---|---|
| Age ≥60 years | -0.872 | 0.403 | 4.675 | 0.031 | 0.418 | 0.190-0.922 |
| Presence of diabetes | -0.922 | 0.444 | 4.307 | 0.038 | 0.398 | 0.166-0.950 |
| Preoperative lumbar spondylolisthesis degree ≥ II | 1.307 | 0.408 | 7.293 | 0.001 | 1.697 | 1.663-4.217 |
| Preoperative JOA score <10 | -0.711 | 0.121 | 34.679 | 0.000 | 0.491 | 0.388-0.622 |

Note: JOA: Japanese Orthopedic Association Score.

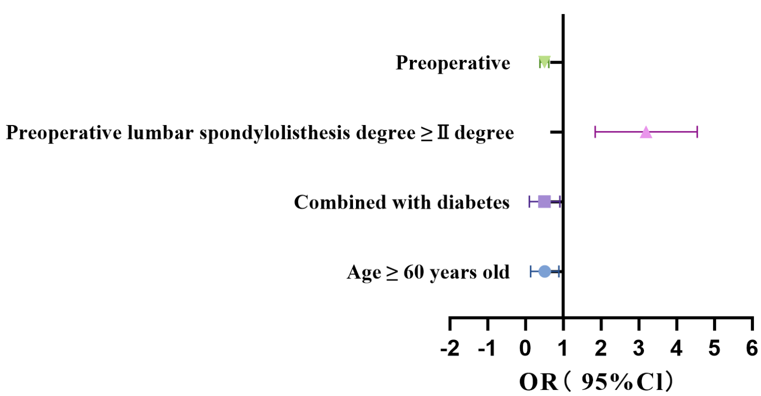


**Figure 2.** Forest plot of multivariate logistic regression analysis of factors influencing the prognosis in patients undergoing ELIF. Note: ELIF: Endoscopic Lumbar Intervertebral Disc Fusion, PLIF: Posterior Lumbar Intervertebral Disc Fusion.

lumbar spondylolisthesis, reestablishing lumbar lordosis, and expanding the cross-sectional area of the dural sac. The improved outcomes may be attributed to ELIF's endoscopic precision, which facilitates accurate vertebrae repositioning and minimizes iatrogenic nerve injury. This study corroborates these benefits: the ELIF group demonstrated significantly greater improvement in spondylolisthesis correction compared to PLIF, likely due to better intraoperative control of vertebral displacement and reduced surgical disruption. Supporting this, Li et al. [11] reported favorable results with percutaneous endoscopic techniques in degenerative lumbar cases, particularly highlighting reduced tissue trauma and faster recovery. Similarly, Yang et al. [17] found that minimally invasive procedures, such as ELIF, were advantageous in managing adjacent segment disease, offering lower surgical risk profiles and shorter recovery periods. Similarly, He et al. [16] observed that percutaneous endoscopic procedures, such as ELIF, result in reduced blood loss and quicker recovery, which supports our findings regarding postoperative recovery advantages.

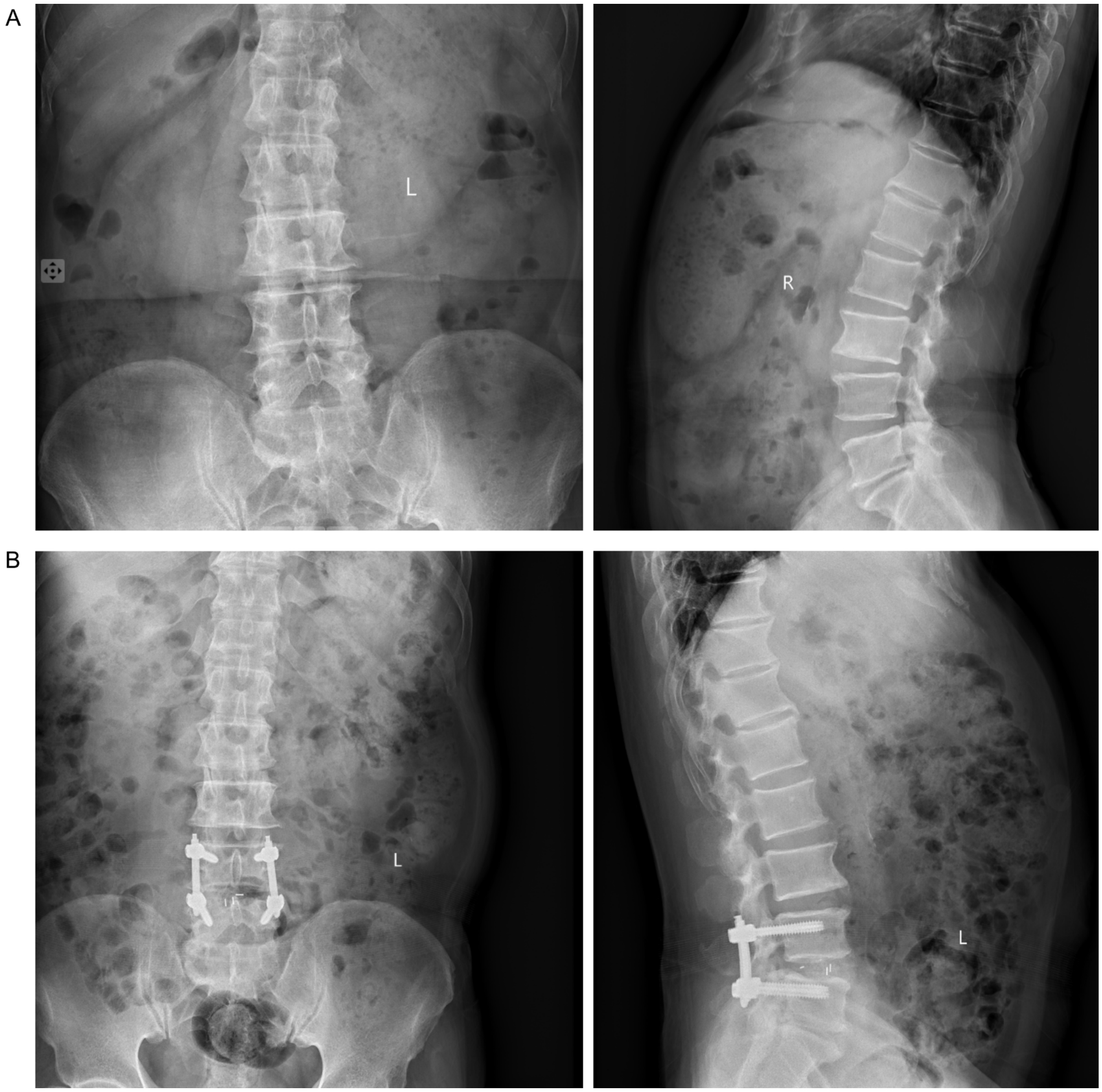


**Figure 3.** Preoperative and postoperative imaging evaluation. A. Preoperative X-ray image shows an L4/5 disc herniation with lumbar instability. B. Postoperative X-ray image shows good intervertebral implant fusion with maintenance of intervertebral height at postoperative 12 months.

Logistic regression analysis further identified key risk factors influencing the prognosis of patients receiving ELIF. Age ≥60 years, diabetes, preoperative lumbar spondylolisthesis grade ≥ II, and preoperative JOA score <10 were identified as significant predictors of poor prognosis. As patients age, they experience decreased bone density and reduced spinal stability, leading to slower recovery. Diabetic patients are at an increased risk of poor wound healing and postoperative infections due to chronic hyperglycemia, which negatively impacts their prognosis [21, 22]. Additionally, patients with more severe preoperative lumbar spondylolisthesis exhibit poor spinal stability, complicating recovery. Those with lower preoperative JOA scores often suffer from greater neurological impairments, further hindering postoperative recovery [23]. These findings align with existing literature, which highlights age and diabetes as critical factors influencing spinal surgery outcomes, particularly in minimally invasive procedures where elderly and diabetic patients tend to recover more slowly [24, 25]. Preoperative functional scores and imaging assessments, such as the degree of lumbar spondylolisthesis, have also been shown to significantly impact surgical outcomes.

Despite the valuable insights provided, several limitations of this study should be acknowledged. First, this is a retrospective study, which may introduce biases related to patient selection and data collection. The lack of randomization limits the ability to draw definitive conclusions about the superiority of ELIF over PLIF. Second, the follow-up period was limited to 1 year, which means long-term outcomes, such as the incidence of complications like adjacent segment disease, recurrence of instability, or degeneration at other levels, remain unknown. Additionally, this study focused on short-term functional recovery and didn't address other important factors, such as the cost-effectiveness of the procedures or the patients' overall quality of life after surgery. Finally, while several risk factors for a poorer outcome were identified, the sample size may have been too small to capture all potential factors. Future studies will need to follow a larger cohort of patients over a longer period to confirm these findings and explore additional variables that may influence surgical outcomes.

## Conclusion

ELIF offers significant benefits in treating lumbar instability, including reduced operation time, improved recovery, and enhanced function recovery. Identifying risk factors for poor prognosis can help clinicians optimize treatment strategies and improve patient outcomes.

## Disclosure of conflict of interest

None.

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