# European Journal of Clinical Pharmacy

**Print ISSN:** 2385-409X, **Online ISSN**: 3105-0409
Website: https://farmclin.com/


*Original Research*

# Comparison of the Outcomes of Laminectomy plus Fusion Vs Laminectomy Alone in the Treatment of Lumbar Spinal Stenosis with Spondylolisthesis


***Article History:***



**Name of Author:**
Iqra Yasin[1], Rida Yasin[2], Muhammad Shahid[3], Waleed Yasin[4], Fatima Yasin[5]

***Affiliation:*** *[1,2,3] Department of Neurosurgery, Bahwal Victoria Hospital, Quaid-e-Azam Medical College, Bahawalpur, Pakistan*
*[4]MBBS, Sheikh Zayed Medical College, Rahim Yar Khan*
*[5]MBBS, Aga Khan Medical College, Karachi, Pakistan*

***Corresponding Author:***
Dr. Iqra Yasin,
Email : iqra.serene@gmail.com



***Received:*** 26-08-2025
***Revised:*** 21-10-2025
***Accepted:*** 08-11-2025
***Published:*** 25-11-2025





***Abstract:*** Background: Surgery is generally indicated for the treatment of lumbar spinal stenosis with degenerative spondylolisthesis, but the advantages of laminectomy with fusion versus laminectomy alone is still subject of debate. **Objective:** To evaluate the clinical, surgical, and complication results of laminectomy and fusion versus laminectomy alone in patients with lumbar spinal stenosis and low-grade spondylolisthesis. **Methodology:** The present RTC was carried out at the Department of Neurosurgery, Bahawal Victoria Hospital, Bahawalpur, Pakistan, from July 2023 to January 2024, with 84 patients of grade I-II spondylolisthesis and lumbar spinal stenosis. Forty-two patients each received laminectomy and fusion (Group A) and forty-two patients received laminectomy alone (Group B). The outcomes measured were the Oswestry Disability Index (ODI), the Visual Analog Scale (VAS), the time required to perform the procedure (operative time), hospital length of stay, and postoperative complications. **Results:** Mean age was 62.83 ± 6.16 years, and 65 (77.4%) patients were female. ODI was significantly lower with fusion than laminectomy alone (22.14 ± 4.89 vs. 30.50 ± 12.24; p<0.001), while postoperative VAS was comparable (2.80 ± 1.10 vs. 2.97 ± 1.23; p=0.518). Fusion required longer operative time (220.33 ± 17.26 vs. 146.80 ± 16.50 minutes; p<0.001) and hospital stay (3.42 ± 0.76 vs. 2.54 ± 0.70 days; p<0.001). Nerve-root injury occurred in 5 (11.9%) versus 7 (16.7%), infection in 7 (16.7%) versus 5 (11.9%), re-operation in 2 (4.8%) versus 5 (11.9%), and readmission in 1 (2.4%) versus 3 (7.1%) patients in Groups A and B, respectively, with no significant differences. **Conclusion:** There were similar rates of complications and pain post-surgery, but laminectomy combined with fusion had longer surgical and recovery times, and resulted in improved functional outcomes.



***Keywords:*** Lumbar spinal stenosis; degenerative spondylolisthesis; laminectomy; spinal fusion; Oswestry Disability Index; Visual Analog Scale.


## INTRODUCTION

Lumbar spinal stenosis (LSS) is a common degenerative spinal disorder characterized by narrowing of the spinal canal and/or neural foramina, resulting in compression of the lumbar neural elements [1]. It predominantly affects older adults and commonly presents with neurogenic claudication, low back pain, radicular symptoms, sensory disturbances, and varying degrees of lower-extremity weakness [2]. The condition can substantially restrict walking ability and daily physical activity. Degenerative changes involving the intervertebral discs, facet joints, and ligamentum flavum contribute to progressive narrowing of the spinal canal, while coexisting degenerative spondylolisthesis may further compromise neural structures [3].

Degenerative lumbar spondylolisthesis, particularly at the L4–L5 level, is frequently associated with lumbar spinal stenosis [4]. It results from degenerative changes in the facet joints and intervertebral discs that permit anterior displacement of one vertebra relative to another. The presence of spondylolisthesis may increase mechanical instability and can complicate surgical decision-making [5]. Although many patients initially respond to conservative measures such as

analgesics, physiotherapy, activity modification, and epidural interventions, persistent neurological symptoms or functional limitation may require surgical treatment [6].

Laminectomy is a widely established decompressive procedure for lumbar spinal stenosis [7]. By removing portions of the lamina and other structures contributing to neural compression, decompression can relieve pressure on the affected nerve roots and improve pain and walking capacity [8]. However, decompression alone may potentially contribute to postoperative instability in selected patients, particularly when substantial facet joint resection is required or pre-existing instability is present. Consequently, spinal fusion is often performed in conjunction with laminectomy to provide additional segmental stabilization and maintain spinal alignment [9].

Laminectomy combined with instrumented fusion can provide both neural decompression and mechanical stabilization, but it involves greater operative exposure and may be associated with increased blood loss, longer operative time, longer hospitalization, and procedure-related complications [10,11]. In contrast, laminectomy alone is generally less extensive and may offer advantages in operative recovery, although concerns remain regarding postoperative instability and recurrent symptoms in patients with associated spondylolisthesis [12]. Thus, the choice between decompression alone and decompression with fusion remains an important clinical consideration.

### Research Objective

To compare the outcomes of laminectomy plus fusion versus laminectomy alone in the treatment of lumbar spinal stenosis with spondylolisthesis.

## MATERIALS AND METHODS

### Study Design and Setting

The study was conducted at Bahawal Victoria Hospital, Neurosurgery department, Bahawalpur from 18 July 2023 to 17 January 2024 in a randomized controlled trial (RCT) format. The study was started after ethical approval was received from the institutional ethical review committee. All eligible participants signed a written informed consent prior to enrollment.

### Sample Size and Sampling Technique

A total sample size of 84 patients was calculated using the OpenEpi sample size calculator, with 90% confidence and 80% power, based on the expected mean postoperative pain scores of 3.85 ± 0.73 in patients undergoing laminectomy with fusion and 4.36 ± 1.11 in those undergoing laminectomy alone [13]. Patients were recruited using a non-probability consecutive sampling technique.

### Patient Selection

The inclusion criteria were patients with lumbar spinal stenosis (LSS) who had symptoms for more than 6 months and had grade I or II lumbar spondylolisthesis (LS). Patients were excluded if they had grade III or higher spondylolisthesis, previous history of lumbar spinal surgery, spondylolysis, degenerative lumbar scoliosis with a Cobb angle larger than 20°, or spinal stenosis due to intervertebral disc herniation. Other specific spinal disorders, such as ankylosing spondylitis, malignancy or neurological disorders, and a history of vertebral compression fracture at the affected segment were also excluded.

### Data Collection and Randomization

Baseline demographic and clinical features, such as age, sex, BMI, symptoms duration, Medical History and physical examination findings were obtained after enrollment. All subjects were examined preoperatively, including plain X-ray and magnetic resonance imaging (MRI) studies and laboratory examinations. Forty two patients who completed the laminectomy and fusion procedure were randomly assigned to Group A and 42 patients who underwent laminectomy alone were randomly assigned to Group B. Patients in Group A were treated with instrumented fusion of the level of spondylolisthesis with pedicle screws and titanium alloy rods for stabilization and bone harvested from the iliac crest for fusion. Group B patients were treated with laminectomy only without instrumented fusion. In both groups, neural decompression was achieved by making a complete laminectomy and removing a small portion of the medial facet joint. Neurosurgery procedures were all done electively by highly experienced neurosurgeons who had at least five years of post-fellowship.

### Outcome Assessment

Data on operative and postoperative parameters were prospectively collected. These comprised operative time, length of hospital stay and whether there was an intra- or post-operative complication. Factors evaluated for complications were nerve-root injury, dural tear, postoperative infection, reoperation, and readmission. Visual Analog Scale (VAS) for back pain and Oswestry Disability Index (ODI) for functional disability were used to evaluate clinical outcomes. Preoperative and 1, 3, and 6 months postoperative VAS and ODI scores were recorded. All the information collected was recorded on a data collection proforma and entered into a computerised database for analysis.

### Statistical Analysis

Data were coded, analyzed and interpreted using SPSS software (Version 25.0) from IBM. Data on continuous variables such as age, duration of symptoms, operative time, hospital stay, VAS and ODI scores are summarized as Mean ± SD, and categorical variables are expressed as numbers and percentages. Normality of the distribution of continuous variables was checked prior to statistical

analysis. Normally distributed continuous data were compared between two treatment groups using independent-samples t-test, and categorical variables were compared using the chi-square test and Fisher's exact test, respectively. Comparisons were made between groups at the pre-specified follow-up time points with regards to the changes in postoperative VAS and ODI scores. Stratification was performed to investigate potential confounding and effect-modifying variables (such as age, sex and symptom duration) and post-stratification analysis was undertaken with the chi-square test as appropriate. Statistically significant p value was defined as ≤ 0.05 on both sides.

## RESULT

Table 1 shows that the mean age was comparable between Group A and Group B (62.35 ± 6.20 vs. 63.30 ± 6.16 years; $p$=0.482), with females predominating in both groups (78.6% vs. 76.2%; $p$=0.794). Group A had significantly longer operative time (220.33 ± 17.26 vs. 146.80 ± 16.50 minutes) and hospital stay (3.42 ± 0.76 vs. 2.54 ± 0.70 days; both $p$<0.001). ODI was significantly lower in Group A (22.14 ± 4.89 vs. 30.50 ± 12.24; $p$<0.001), while postoperative VAS was comparable (2.80 ± 1.10 vs. 2.97 ± 1.23; $p$=0.518). Rates of nerve-root injury, dural tear, infection, re-operation, and readmission were not significantly different between groups.

**Table 1. Comparison of Demographic, Perioperative, and Clinical Outcomes between the Study Groups**

| Variable | Category / Measurement | Total Patients (N=84) | Group A: Laminectomy + Fusion (n=42) | Group B: Laminectomy Alone (n=42) | P-value |
|---|---|---|---|---|---|
| **Age (years)** | Mean ± SD | 62.83 ± 6.16 | 62.35 ± 6.20 | 63.30 ± 6.16 | 0.482 |
| **Gender** | Male, n (%) | 19 (22.6%) | 9 (21.4%) | 10 (23.8%) | 0.794 |
| | Female, n (%) | 65 (77.4%) | 33 (78.6%) | 32 (76.2%) | |
| **Operative time (minutes)** | Mean ± SD | 183.57 ± 40.61 | 220.33 ± 17.26 | 146.80 ± 16.50 | <0.001 |
| **Length of hospital stay (days)** | Mean ± SD | 2.98 ± 0.85 | 3.42 ± 0.76 | 2.54 ± 0.70 | <0.001 |
| **Nerve root injury** | Yes, n (%) | 12 (14.3%) | 5 (11.9%) | 7 (16.7%) | 0.533 |
| | No, n (%) | 72 (85.7%) | 37 (88.1%) | 35 (83.3%) | |
| **Dural tearing** | Yes, n (%) | 3 (3.6%) | 2 (4.8%) | 1 (2.4%) | 1.000 |
| | No, n (%) | 81 (96.4%) | 40 (95.2%) | 41 (97.6%) | |
| **Postoperative infection** | Yes, n (%) | 12 (14.3%) | 7 (16.7%) | 5 (11.9%) | 0.533 |
| | No, n (%) | 72 (85.7%) | 35 (83.3%) | 37 (88.1%) | |
| **Re-operation** | Yes, n (%) | 7 (8.3%) | 2 (4.8%) | 5 (11.9%) | 0.433 |
| | No, n (%) | 77 (91.7%) | 40 (95.2%) | 37 (88.1%) | |
| **Re-admission** | Yes, n (%) | 4 (4.8%) | 1 (2.4%) | 3 (7.1%) | 0.616 |
| | No, n (%) | 80 (95.2%) | 41 (97.6%) | 39 (92.9%) | |
| **Oswestry Disability Index (ODI)** | Mean ± SD | 26.32 ± 10.17 | 22.14 ± 4.89 | 30.50 ± 12.24 | <0.001 |
| **Preoperative back pain (VAS)** | Mean ± SD | 7.23 ± 1.47 | 7.00 ± 1.46 | 7.47 ± 1.46 | 0.141 |
| **Postoperative back pain (VAS)** | Mean ± SD | 2.89 ± 1.17 | 2.80 ± 1.10 | 2.97 ± 1.23 | 0.518 |

Among patients aged 50–64 years, Group A had significantly lower ODI scores than Group B (21.82 ± 4.93 vs. 31.76 ± 11.87; p=0.001), while postoperative VAS was comparable (p=0.118), shown in table 2. Operative time and hospital stay were significantly longer with fusion (223.47 ± 17.26 vs. 148.09 ± 14.46 minutes and 3.34 ± 0.77 vs. 2.71 ± 0.78 days; p<0.001 and p=0.010). In patients aged 65–75 years, ODI remained significantly lower with fusion (22.52 ± 4.95 vs. 29.23 ± 12.77; p=0.038), whereas operative time and hospital stay were again significantly longer (p<0.001). Complication rates were comparable between groups in both age categories.

**Table 2. Association of Age with Clinical and Perioperative Outcomes**

**A. Age group 50–64 years**

| Outcome | Group A: Laminectomy + Fusion (n=23) | Group B: Laminectomy Alone (n=21) | P-value |
|---|---|---|---|
| ODI, mean ± SD | 21.82 ± 4.93 | 31.76 ± 11.87 | 0.001 |
| Postoperative VAS, mean ± SD | 2.60 ± 1.15 | 3.14 ± 1.06 | 0.118 |
| Operative time (minutes), mean ± SD | 223.47 ± 17.26 | 148.09 ± 14.46 | <0.001 |
| Hospital stay (days), mean ± SD | 3.34 ± 0.77 | 2.71 ± 0.78 | 0.010 |
| Nerve root injury, n (%) | 3 (13.0%) | 5 (23.8%) | 0.448 |
| Dural tearing, n (%) | 0 (0.0%) | 1 (4.8%) | 0.477 |
| Infection, n (%) | 3 (13.0%) | 3 (14.3%) | 1.000 |
| Re-operation, n (%) | 1 (4.3%) | 2 (9.5%) | 0.599 |
| Re-admission, n (%) | 0 (0.0%) | 1 (4.8%) | 0.477 |

**B. Age group 65–75 years**

| Outcome | Group A: Laminectomy + Fusion (n=19) | Group B: Laminectomy Alone (n=21) | P-value |
|---|---|---|---|
| ODI, mean ± SD | 22.52 ± 4.95 | 29.23 ± 12.77 | 0.038 |
| Postoperative VAS, mean ± SD | 3.05 ± 1.02 | 2.80 ± 1.40 | 0.533 |
| Operative time (minutes), mean ± SD | 216.52 ± 16.93 | 145.52 ± 18.59 | <0.001 |
| Hospital stay (days), mean ± SD | 3.52 ± 0.77 | 2.38 ± 0.58 | <0.001 |
| Nerve root injury, n (%) | 2 (10.5%) | 2 (9.5%) | 1.000 |
| Dural tearing, n (%) | 2 (10.5%) | 0 (0.0%) | 0.219 |
| Infection, n (%) | 4 (21.1%) | 2 (9.5%) | 0.398 |
| Re-operation, n (%) | 1 (5.3%) | 3 (14.3%) | 0.607 |
| Re-admission, n (%) | 1 (5.3%) | 2 (9.5%) | 1.000 |

Among male patients, ODI and postoperative VAS did not differ significantly between groups, although operative time and hospital stay were significantly longer with fusion (216.00 ± 19.64 vs. 146.30 ± 10.00 minutes, p<0.001; 3.77 ± 0.83 vs. 2.90 ± 0.87 days, p=0.039), shown in table 3. Among female patients, Group A had significantly lower ODI scores than Group B (22.24 ± 4.93 vs. 31.03 ± 11.76; p<0.001), with significantly longer operative time and hospital stay (p<0.001 for both). Postoperative VAS and complication rates were not significantly different between groups in either sex.

**Table 3. Association of Gender with Clinical and Perioperative Outcomes**

**A. Male patients**

| Outcome | Group A: Laminectomy + Fusion (n=9) | Group B: Laminectomy Alone (n=10) | P-value |
|---|---|---|---|
| ODI, mean ± SD | 21.77 ± 5.01 | 28.80 ± 14.22 | 0.179 |
| Postoperative VAS, mean ± SD | 3.00 ± 1.11 | 2.80 ± 1.54 | 0.749 |
| Operative time (minutes), mean ± SD | 216.00 ± 19.64 | 146.30 ± 10.00 | <0.001 |
| Hospital stay (days), mean ± SD | 3.77 ± 0.83 | 2.90 ± 0.87 | 0.039 |
| Nerve root injury, n (%) | 1 (11.1%) | 1 (10.0%) | 1.000 |
| Dural tearing, n (%) | 1 (11.1%) | 1 (10.0%) | 1.000 |
| Infection, n (%) | 3 (33.3%) | 3 (30.0%) | 1.000 |
| Re-operation, n (%) | 0 (0.0%) | 2 (20.0%) | 0.474 |
| Re-admission, n (%) | 0 (0.0%) | 1 (10.0%) | 1.000 |

**B. Female patients**

| Outcome | Group A: Laminectomy + Fusion (n=33) | Group B: Laminectomy Alone (n=32) | P-value |
|---|---|---|---|
| ODI, mean ± SD | 22.24 ± 4.93 | 31.03 ± 11.76 | <0.001 |
| Postoperative VAS, mean ± SD | 2.75 ± 1.11 | 3.03 ± 1.14 | 0.335 |
| Operative time (minutes), mean ± SD | 221.51 ± 16.69 | 146.96 ± 18.19 | <0.001 |
| Hospital stay (days), mean ± SD | 3.33 ± 0.73 | 2.43 ± 0.61 | <0.001 |
| Nerve root injury, n (%) | 4 (12.1%) | 6 (18.8%) | 0.511 |
| Dural tearing, n (%) | 1 (3.0%) | 0 (0.0%) | 1.000 |
| Infection, n (%) | 4 (12.1%) | 2 (6.3%) | 0.672 |
| Re-operation, n (%) | 2 (6.1%) | 3 (9.4%) | 0.672 |
| Re-admission, n (%) | 1 (3.0%) | 2 (6.3%) | 0.613 |

## DISCUSSION

In this randomized study, surgical treatment was beneficial in both groups of patients with lumbar spinal stenosis and low-grade spondylolisthesis, and fusion was correlated with improved functional status. The postoperative ODI was significantly lower with laminectomy plus fusion than with laminectomy alone (22.14 ± 4.89 vs. 30.50 ± 12.24; p<0.001), whereas postoperative VAS was similar (2.80 ± 1.10 vs. 2.97 ± 1.23; p=0.518). These results indicate that the fusion procedure also offers an extra functional advantage, in addition to the pain relief. The results are also in part comparable with the study by Ghogawala et al (2016) in which the improvement of ODI was not statistically significant between the groups although the fusion group showed better improvement in overall physical health [14].

When stratified according to age, the functional benefit of fusion was also apparent in our study. Among patients aged 50–64 years, ODI was significantly lower following fusion (21.82 ± 4.93 vs. 31.76 ± 11.87; p=0.001), and a similar difference was observed among those aged 65–75 years (22.52 ± 4.95 vs. 29.23 ± 12.77; p=0.038). However, postoperative VAS was not significantly different for both of the above age groups. The results suggest that the perceived benefits of fusion were greater for disability than for pain. The NORDSTEN-DS randomized trial showed, however, that there was no difference between the two groups in terms of disability at 2 years after surgery, and that routine fusion is not required for all patients with degenerative spondylolisthesis (DS) [15].

One of the most significant findings of the present study is that the operative burden associated with fusion was significantly greater. Mean operative time was 220.33 ± 17.26 minutes in Group A compared with 146.80 ± 16.50 minutes in Group B (p<0.001), while hospital stay was 3.42 ± 0.76 versus 2.54 ± 0.70 days, respectively (p<0.001). This pattern persisted following age and sex stratification. This is consistent with recent studies indicating that decompression alone typically leads to shorter surgery and hospital stay. Gadjradj et al. (2023) reported good quality evidence for comparable functional and pain outcomes, but for shorter hospital stay and less blood loss with decompression alone [16].

However, in our series, operative exposure did not significantly affect individual complications. Nerve-root injury occurred in 11.9% versus 16.7% (p=0.533), dural tearing in 4.8% versus 2.4% (p=1.000), infection in 16.7% versus 11.9% (p=0.533), re-operation in 4.8% versus 11.9% (p=0.433), and readmission in 2.4% versus 7.1% (p=0.616) in the fusion and decompression-alone groups, respectively. Age- and sex-specific analyses also revealed no significant differences in the complications. This is similar to the results of other systematic reviews and meta-analyses that have found comparable complication and re-operation rates between decompression and fusion and decompression alone, despite the length of the surgery, increased blood loss, and increased hospital stays in the fusion group [17].

In the present study gender-specific analysis revealed that the benefits of fusion were more apparent in women. The difference in ODI scores was significant between female patients with fusion and laminectomy alone (22.24 ± 4.93 vs. 31.03 ± 11.76; p<0.001), but not significant between men (21.77 ± 5.01 vs. 28.80 ± 14.22; p=0.179). Nevertheless, fusion required significantly longer operative time in both men (216.00 vs. 146.30 minutes; p<0.001) and women (221.51 vs. 146.96 minutes; p<0.001). Although these findings should be taken with a grain of salt as the male sub-group was not large and the study was not designed specifically to detect sex-treatment interaction. Recent prospective data on degenerative lumbar spondylolisthesis also showed that sex may be a factor on the decision to perform surgery, but it seems to be a factor due to clinical and radiographic indications and not to sex itself [18]. Therefore, the current results support the idea of an individualized

approach in surgical decision making and not be based exclusively on gender.

In sum, our results show a perioperative cost–benefit relationship, with a compromise in functional outcomes. Fusion had no significant difference in the overall and stratified ODI scores, but significantly longer surgery and hospital stay, with no difference in postoperative pain or complications. This differs from the NORDSTEN-DS trial and recent systematic reviews that suggest decompression surgery generally is enough for most patients with low-grade degenerative spondylolisthesis. The difference between the procedures was a trivial difference: meta-analysis of randomized trials found an MD of 0.86, 95% CI −4.53 to 6.26 ODI [19]. Thus, our findings suggest that fusion could be of particular benefit when functional outcome is the main goal, but the additional operative time and length of hospital stay must be considered.

**Strength and Limitations**

A significant advantage of this randomized controlled trial is the direct comparison between the two groups of patients with laminectomy with fusion versus laminectomy alone in a cohort of patients with lumbar spinal stenosis and low-grade degenerative spondylolisthesis with equal group sizes between the two treatment arms. Functional disability (Oswestry Disability Index (ODI)), postoperative pain (Visual Analog Scale (VAS)), operating time, hospital length of stay, and complications of the procedure were clinically relevant outcomes assessed. The findings are supported by randomisation, a standard surgical procedure, a prospective recording of outcomes and further age and sex-stratified analyses. Several constraints should be taken into account, however. Due to the limited number of patients included in the study (84 patients) and being conducted in a single tertiary-care center, there may be limited power and generalizability. Follow-up was only for 6 months and therefore did not include assessment of longer-term outcomes of stenosis recurrence, progression of spondylolisthesis, adjacent-segment disease or late reoperation. Also, the study was not designed specifically to identify treatment effects in age or sex subgroups and the absence of formal interaction testing restricts the ability to interpret differences between subgroups. Other potentially important measures like blood loss, radiographic progression, fusion status, or quality of life measures were not included in the study.

## CONCLUSION

Finally, it was concluded that the two procedures (laminectomy with fusion and laminectomy) resulted in comparable postoperative improvements in patients with LSS with low-grade spondylolisthesis. Laminectomy plus fusion was correlated with significantly improved postoperative functional status (lower ODI scores), but similar postoperative pain (VAS scores) were obtained between laminectomy plus fusion and laminectomy alone. Fusion did, however, take much longer operative time and hospital stay with no significant difference in nerve-root injury, dural tear, infection, re-operation, or readmission. These results indicate that, in certain patients with degenerative spondylolisthesis, fusion could offer a further postoperative advantage, but this needs to be balanced against the increased peri-operative workload. Routine fusion of the entire population of patients should not be performed, and it should be used based on patient's clinical symptoms, functional impairment, spinal stability and surgical requirements.

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