

# COMPARISON OF SURGICAL OUTCOMES OF DECOMPRESSIVE LAMINECTOMY VERSUS DECOMPRESSIVE LAMINECTOMY WITH TRANSPEDICULAR SCREW FIXATION IN PATIENTS WITH MULTILEVEL LUMBAR SPINAL STENOSIS

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## ABSTRACT

**Background:** Lumbar spinal stenosis (LSS) is a common degenerative condition that produces neurogenic claudication, radicular pain, and progressive functional disability, and surgery is considered once conservative measures fail. Decompressive laminectomy relieves neural compression, but whether transpedicular screw fixation should be added remains debated, particularly when several levels are involved. This study compared the two approaches in patients with multilevel LSS.

**Methods:** This randomised controlled trial was conducted at the Department of Neurosurgery, Services Hospital, Lahore, between 07 October 2025 and 07 January 2026. Sixty patients with multilevel LSS were randomly allocated in a 1:1 ratio by the lottery method to two groups. Group A underwent decompressive laminectomy alone, and Group B underwent decompressive laminectomy with transpedicular screw fixation. Patients and outcome assessors were blinded to allocation. Operative time, Visual Analogue Scale (VAS) pain scores at 7 days and 3 months, the Oswestry Disability Index (ODI), bony fusion, spinal stability, and neurological status were assessed at 3 months. The data was analysed using SPSS Version 27.0.

**Results:** The mean age was  $45.37 \pm 4.76$  years and 36 patients (60.0%) were male. Operative time was markedly longer in Group B ( $196.3 \pm 25.9$  vs.  $105.0 \pm 7.4$  minutes;  $p < 0.001$ ). Despite this, Group B showed better pain relief at 7 days (median VAS 3.0 vs. 4.0;  $p = 0.006$ ) and 3 months (2.0 vs. 3.0;  $p = 0.001$ ), lower disability (ODI  $23.20 \pm 5.57\%$  vs.  $28.60 \pm 4.99\%$ ;  $p = 0.0002$ ), and higher rates of minimal disability (40.0% vs. 6.7%;  $p = 0.002$ ), bony fusion (90.0% vs. 60.0%;  $p = 0.007$ ), preserved spinal stability (96.7% vs. 73.3%;  $p = 0.026$ ), and neurological improvement (93.3% vs. 66.7%;  $p = 0.010$ ).

**Conclusions:** In multilevel LSS, adding transpedicular screw fixation to decompressive laminectomy was associated with better early pain relief, functional recovery, radiological stability, and neurological improvement, at the cost of a substantially longer operative time. Because larger trials of predominantly single-level disease have found decompression alone to be non-inferior, fixation is best reserved for selected patients at higher risk of postoperative instability.

**KEYWORDS:** decompressive laminectomy, lumbar spinal stenosis, neurogenic claudication, oswestry disability index, spinal stability, transpedicular screw fixation, visual analogue scale

## INTRODUCTION

Lumbar spinal stenosis (LSS) is a degenerative narrowing of the spinal canal, lateral recesses, or intervertebral foramina that compresses neural structures. It typically presents with neurogenic claudication, radiating leg pain, sensory disturbance, and difficulty walking, with symptoms that worsen on lumbar extension and ease with flexion or sitting [1,2]. The condition affects roughly 11% of older adults, with prevalence climbing steeply after age 60, and it commonly coexists with other degenerative changes that accumulate in the ageing spine [2,3]. Magnetic resonance imaging (MRI) is the standard investigation for confirming canal and foraminal narrowing and correlating it with the clinical picture [1,2]. Physiotherapy and analgesia remain first-line treatment, and surgical decompression is considered for patients whose symptoms persist despite an adequate course of conservative care [2,4].

Decompressive laminectomy widens the canal by removing the posterior arch of the affected vertebra. When several levels are decompressed, however, this wide exposure can disrupt the posterior ligamentous complex and facet joints, destabilising the spine and leading to segmental instability, progressive listhesis, and persistent back pain. Transpedicular screw fixation with posterolateral fusion is therefore frequently added to restore stability after

extensive decompression [5]. Comparisons of decompression alone versus decompression with fixation have generally reported similar pain relief and functional improvement between groups, with the fixation group requiring a longer operative time and incurring greater blood loss [6,7].

Despite this body of work, there is no clear consensus on the best approach for multilevel disease. Most comparative trials have studied single- or two-level stenosis, and evidence specific to multilevel involvement, where the risk of postoperative instability is greatest, remains limited [8,9]. Pooled analyses have found no significant difference in functional outcome between decompression alone and decompression with fusion at two years, while consistently showing that decompression alone is associated with a shorter operative time, less blood loss, and a shorter hospital stay [7,8]. These trade-offs carry particular weight in resource-limited settings, where longer operations and higher complication rates translate directly into greater cost and morbidity. The present study was therefore conducted to compare the surgical outcomes of decompressive laminectomy alone with decompressive laminectomy plus transpedicular screw fixation in patients with multilevel LSS, focusing on pain relief, functional recovery, operative burden, and spinal stability.

## MATERIALS AND METHODS

This randomised controlled trial was carried out at the Department of Neurosurgery, Services Hospital, Lahore, between 07 October 2025 and 07 January 2026. Ethical approval was taken from the hospital ethical review committee (Ref. No. IRB/2025/1795/SIMS), and the trial was registered with ClinicalTrials.gov (identifier NCT07281625). Eligible patients were recruited by consecutive sampling. The sample size was estimated using a mean operative time of  $107.80 \pm 15.33$  minutes in the decompression group and  $159.15 \pm 19.58$  minutes in the combination group, with a 5% level of significance and 80% power. To ensure feasibility and equal allocation, 60 patients (30 per group) were included [10].

The 60 enrolled patients were randomly allocated to the two groups in a 1:1 ratio using the lottery method. For each patient, two identical, sealed, opaque slips, one marked for decompressive laminectomy alone (Group A) and one for decompressive laminectomy with transpedicular screw fixation (Group B), were placed in a container, and an independent staff member who was not involved in the surgery or in outcome assessment drew a slip to determine the allocation. Patients were blinded to their group assignment, and the assessors who recorded the VAS, ODI, and radiological outcomes at follow-up were also blinded to allocation. Because the two operations differ in their incision and postoperative imaging, the operating surgeon could not be blinded.

Patients of either sex aged 30 to 60 years were eligible if they had MRI-confirmed lumbar spinal stenosis, with an anteroposterior canal diameter below 10-15 mm and a cross-sectional area below 75-145 mm<sup>2</sup>, together with multilevel lumbar disc herniation and degenerative disc disease graded 3 to 5 on the Pfirrmann scale on T2-weighted MRI [9]. A minimum of six weeks of prior conservative treatment was required. Patients were excluded if they had undergone previous lumbar spinal surgery, or had spinal malignancy, scoliosis or kyphoscoliosis, high-grade spondylolisthesis (grade 3 to 5), or significant comorbidity such as uncontrolled diabetes mellitus or ischaemic heart disease. Written informed consent was obtained from every participant before enrolment.

Group A underwent decompressive laminectomy alone and Group B underwent decompressive laminectomy combined with transpedicular screw fixation, in line with the random allocation. All procedures were performed under general anaesthesia with the patient in the prone position, following standard spinal surgical protocols. Operative time was recorded in minutes from skin incision to skin closure. All patients received standard postoperative care and were followed for three months.

Pain was assessed with the Visual Analogue Scale (VAS), a 10-point self-administered scale anchored by “no pain” (0) and “pain as bad as it could be” (10), recorded at 7 days and 3 months after surgery; the VAS and the ODI are well-validated, convergent measures of pain and disability in lumbar spine populations [11]. Functional outcome was measured using the Oswestry Disability Index (ODI), expressed as a percentage, with 0-20% indicating minimal disability, 21-40% moderate disability, 41-60% severe disability, 61-80% crippling disability, and 81-100% bed-bound status. Radiological assessment used anteroposterior and lateral lumbosacral radiographs, including flexion-extension views, at three months. Bony fusion was recorded when continuity of trabecular bone was seen across the operated segment, and spinal stability was judged by the presence or absence of vertebral listhesis. Neurological outcome was classified as improved when motor power, sensory function, or neurogenic claudication recovered, and as not improved when the deficit was unchanged or progressed. All data were entered on a predefined proforma.

Data were analysed using IBM SPSS Statistics version 27.0. The Shapiro-Wilk test was first applied to assess the distribution of each continuous variable within each group. Normally distributed variables were summarised as mean  $\pm$  standard deviation and compared with the independent-samples Welch t-test, which does not assume equal variances; the effect size was expressed as Cohen's d. Non-normally distributed continuous variables were summarised as median and interquartile range (IQR) and compared with the Mann-Whitney U test, with the rank-biserial correlation (r) as the effect size. Categorical variables were presented as frequencies and percentages and compared using the chi-square test or Fisher's exact test when the expected cell count was  $<5$ , with Cramér's V as the effect size. A two-sided p-value below 0.05 was considered statistically significant.

## RESULTS

Normality testing was performed before any group comparison. As shown in Table 1, age, body mass index (BMI), operative time, and ODI were normally distributed within both groups and were therefore analysed with the Welch t-test, whereas the VAS scores at 7 days and 3 months departed from normality in both groups and were analysed with the Mann-Whitney U test.

**TABLE 1: Shapiro-Wilk normality test results for continuous variables within each surgical group**

Variable	Group A: W (p)	Group B: W (p)	Distribution
Age (years)	0.959 (0.289)	0.973 (0.612)	Normal
Body mass index (kg/m <sup>2</sup> )	0.967 (0.465)	0.972 (0.605)	Normal
Operative time (minutes)	0.994 (1.000)	0.994 (1.000)	Normal
VAS score at 7 days	0.890 (0.005)	0.901 (0.009)	Non-normal
VAS score at 3 months	0.867 (0.001)	0.914 (0.019)	Non-normal
ODI (%)	0.981 (0.862)	0.973 (0.635)	Normal

*W* = Shapiro-Wilk statistic; *VAS* = Visual Analogue Scale; *ODI* = Oswestry Disability Index; *Group A* = decompressive laminectomy alone; *Group B* = decompressive laminectomy with transpedicular screw fixation. Normal distribution defined as  $p \geq 0.05$ .

A total of 60 patients were enrolled, 30 in each group. The mean age was  $45.37 \pm 4.76$  years, with no significant difference between groups (Group A:  $45.10 \pm 4.71$  years; Group B:  $45.63 \pm 4.87$  years). Thirty-six patients (60.0%) were male and 24 (40.0%) were female, with equal distribution across groups. The mean BMI was  $23.54 \pm 2.10$  kg/m<sup>2</sup>; 45 patients (75.0%) had a normal BMI, 14 (23.3%) were overweight, and one (1.7%) was underweight. Preoperative symptom profiles were comparable, with 57 patients (95.0%) reporting lower back pain and intermittent claudication. The baseline characteristics are summarised in Table 2.

**TABLE 2: Baseline demographic and preoperative clinical characteristics of the two surgical groups**

Variable	Overall (n = 60)	Group A (n = 30)	Group B (n = 30)
Age (years), mean $\pm$ SD	$45.37 \pm 4.76$	$45.10 \pm 4.71$	$45.63 \pm 4.87$
<b>Sex, n (%)</b>			
Male	36 (60.0)	18 (60.0)	18 (60.0)
Female	24 (40.0)	12 (40.0)	12 (40.0)
BMI (kg/m <sup>2</sup> ), mean $\pm$ SD	$23.54 \pm 2.10$	$23.37 \pm 2.01$	$23.71 \pm 2.20$
<b>BMI category, n (%)</b>			
Underweight (< 18.5)	1 (1.7)	0 (0.0)	1 (3.3)
Normal (18.5-24.9)	45 (75.0)	23 (76.7)	22 (73.3)
Overweight (25.0-29.9)	14 (23.3)	7 (23.3)	7 (23.3)
<b>Preoperative symptoms, n (%)</b>			
Lower back pain	57 (95.0)	29 (96.7)	28 (93.3)
Sensory deficit	32 (53.3)	14 (46.7)	18 (60.0)
Motor radiculopathy	20 (33.3)	8 (26.7)	12 (40.0)
Intermittent claudication	57 (95.0)	28 (93.3)	29 (96.7)
Bowel/bladder involvement	3 (5.0)	1 (3.3)	2 (6.7)

*SD* = standard deviation; *BMI* = body mass index; *Group A* = decompressive laminectomy alone; *Group B* = decompressive laminectomy with transpedicular screw fixation.

Operative time, pain scores, and functional outcome are compared in Table 3. Because operative time was normally distributed within each group (Table 1), it was analysed parametrically: Group A required a mean of  $105.0 \pm 7.4$  minutes and Group B a mean of  $196.3 \pm 25.9$  minutes, a highly significant difference ( $p < 0.001$ ) with a very large effect size (Cohen's  $d = 4.79$ ). Despite the longer operation, Group B had better pain outcomes. The median VAS score at 7 days was 4.0 (IQR 4.0-5.0) in Group A versus 3.0 (IQR 3.0-4.0) in Group B ( $p = 0.006$ ;  $r = -0.39$ ), and at 3 months it was 3.0 (IQR 2.0-4.0) versus 2.0 (IQR 1.25-3.0) ( $p = 0.001$ ;  $r = -0.47$ ). The mean ODI was  $28.60 \pm 4.99\%$  in Group A and  $23.20 \pm 5.57\%$  in Group B, a significant difference ( $p = 0.0002$ ) with a large effect size (Cohen's  $d = 1.02$ ).

**TABLE 3: Comparison of operative time, pain scores, and functional outcome between the two surgical groups**

Variable	Group A (n = 30)	Group B (n = 30)	Effect size	p-value
Operative time (min), mean $\pm$ SD <sup>a</sup>	$105.0 \pm 7.4$	$196.3 \pm 25.9$	$d = 4.79$	$< 0.001$
VAS at 7 days, median (IQR) <sup>b</sup>	4.0 (4.0-5.0)	3.0 (3.0-4.0)	$r = -0.39$	0.006
VAS at 3 months, median (IQR) <sup>b</sup>	3.0 (2.0-4.0)	2.0 (1.25-3.0)	$r = -0.47$	0.001
ODI (%), mean $\pm$ SD <sup>a</sup>	$28.60 \pm 4.99$	$23.20 \pm 5.57$	$d = 1.02$	0.0002

<sup>a</sup> Welch *t*-test (Cohen's *d* as effect size); <sup>b</sup> Mann-Whitney *U* test (rank-biserial *r* as effect size). *SD* = standard deviation; *IQR* = interquartile range; *VAS* = Visual Analogue Scale; *ODI* = Oswestry Disability Index; *Group A* = decompressive laminectomy alone; *Group B* = decompressive laminectomy with transpedicular screw fixation.

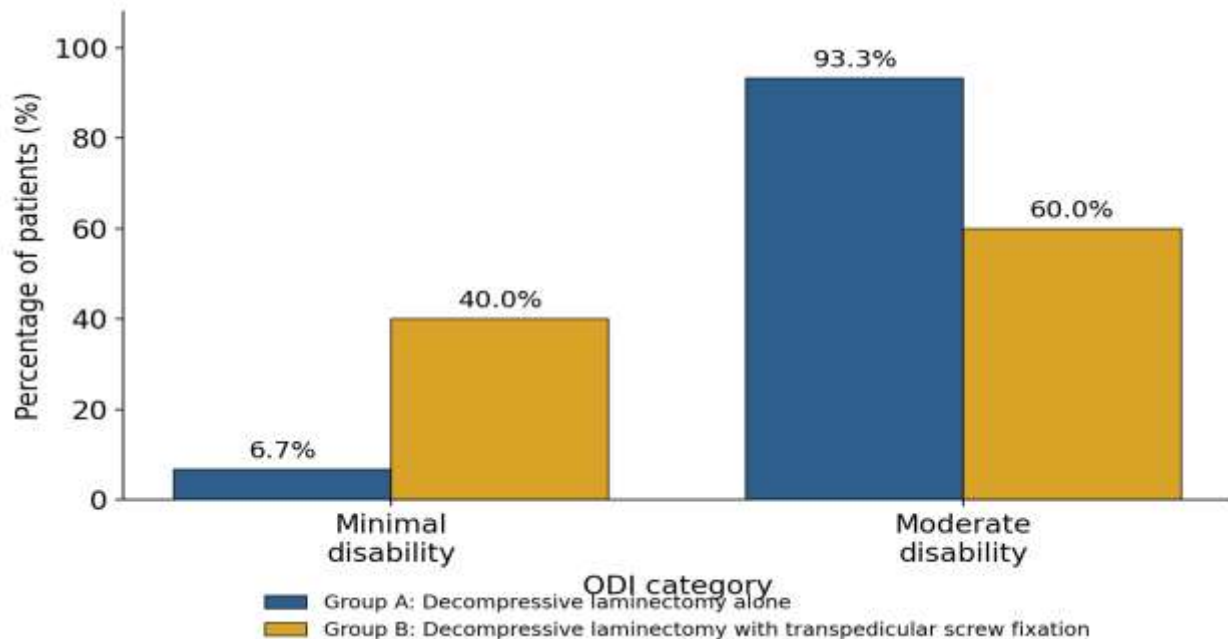
The categorical functional and radiological outcomes are shown in Table 4. A greater proportion of *Group B* patients reached minimal disability on *ODI* categorisation than *Group A* (40.0% vs. 6.7%;  $p = 0.002$ ; Cramer's *V* = 0.394). Bony fusion was seen on plain radiographs in 90.0% of *Group B* versus 60.0% of *Group A* ( $p = 0.007$ ; Cramer's *V* = 0.346). Spinal stability was preserved in 96.7% of *Group B* versus 73.3% of *Group A*, with listhesis present in only one patient (3.3%) in *Group B* compared with eight (26.7%) in *Group A* (Fisher exact  $p = 0.026$ ; Cramer's *V* = 0.327). Neurological improvement was recorded in 28 patients (93.3%) in *Group B* and 20 (66.7%) in *Group A* ( $p = 0.010$ ; Cramer's *V* = 0.333).

**TABLE 4: Comparison of categorical functional and radiological outcomes between the two surgical groups**

Variable	Group A, n (%)	Group B, n (%)	V	p
<b>ODI category<sup>a</sup></b>			<b>0.394</b>	<b>0.002</b>
Minimal disability	2 (6.7)	12 (40.0)		
Moderate disability	28 (93.3)	18 (60.0)		
<b>Bony fusion<sup>a</sup></b>			<b>0.346</b>	<b>0.007</b>
Appreciated	18 (60.0)	27 (90.0)		
Not appreciated	12 (40.0)	3 (10.0)		
<b>Listhesis / spinal instability<sup>b</sup></b>			<b>0.327</b>	<b>0.026</b>
Absent	22 (73.3)	29 (96.7)		
Present	8 (26.7)	1 (3.3)		
<b>Neurological outcome<sup>a</sup></b>			<b>0.333</b>	<b>0.010</b>
Improved	20 (66.7)	28 (93.3)		
Not improved	10 (33.3)	2 (6.7)		

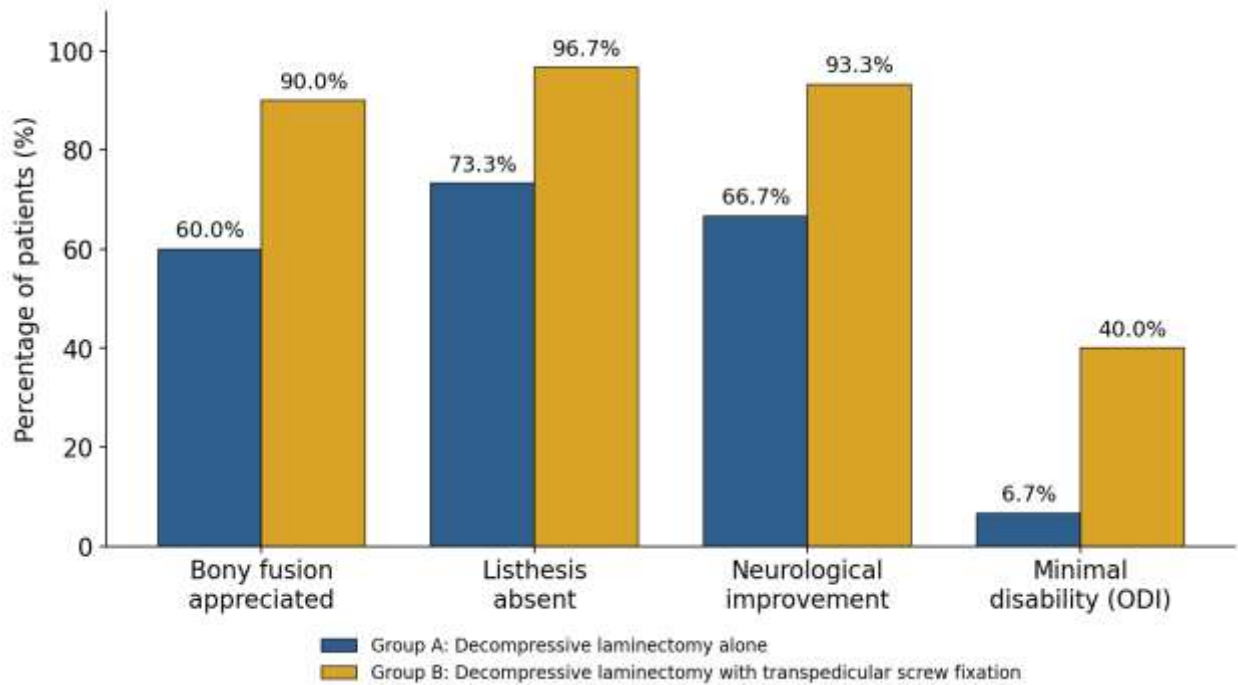
<sup>a</sup> Chi-square test; <sup>b</sup> Fisher exact test. *V* = Cramer's *V*; *ODI* = Oswestry Disability Index; *Group A* = decompressive laminectomy alone; *Group B* = decompressive laminectomy with transpedicular screw fixation.

The distribution of *ODI* categories across groups is illustrated in Figure 1, and a combined view of the four categorical outcomes is shown in Figure 2. Representative preoperative and postoperative imaging is shown in Figures 3 and 4.



**FIGURE 1: Distribution of Oswestry Disability Index categories between the two surgical groups.**

*ODI* = Oswestry Disability Index; *Group A* = decompressive laminectomy alone; *Group B* = decompressive laminectomy with transpedicular screw fixation.

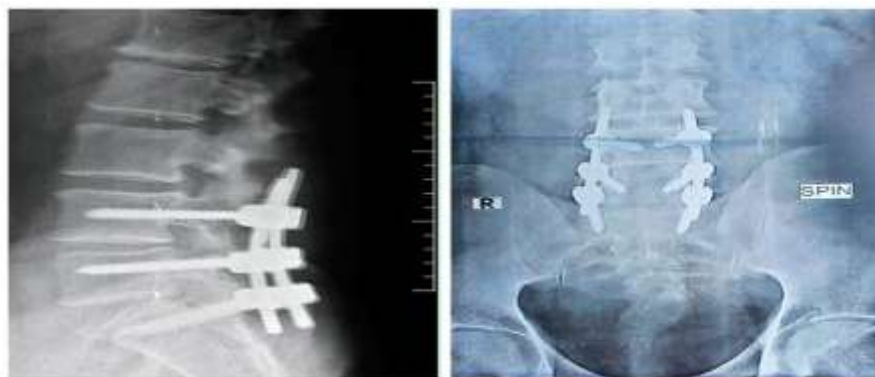


**FIGURE 2: Comparison of categorical functional and radiological outcomes between the two surgical groups.** ODI = Oswestry Disability Index; Group A = decompressive laminectomy alone; Group B = decompressive laminectomy with transpedicular screw fixation.



**FIGURE 3: Preoperative MRI of the lumbosacral spine.**

*T2-weighted MRI of a 55-year-old man with severe back pain and intermittent claudication for five months, showing an L5-S1 herniated disc compromising the right exit foramen and severe spinal canal stenosis at multiple levels. MRI = magnetic resonance imaging.*



**FIGURE 4: Postoperative lumbosacral spine radiographs.**

*Lateral (left) and anteroposterior (right) radiographs of a 55-year-old man after transpedicular screw fixation, demonstrating spinal alignment and accurate placement of the L4-L5-S1 pedicle screws. AP = anteroposterior.*

## DISCUSSION

This trial compared decompressive laminectomy alone with decompressive laminectomy plus transpedicular screw fixation in 60 patients with multilevel LSS. The central finding was that fixation produced better results across all

measured domains, though it required a substantially longer operation. These observations sit within a debate that remains unresolved in the spinal surgery literature [7,8,9].

Operative time in the fixation group was nearly double that of the decompression-only group (196.3 vs. 105.0 minutes). This is consistent with prior work, as pooled analyses confirm that adding fixation lengthens surgery, increases blood loss, and extends hospital stay without a clear functional gain [6,7], and instrumented placement of pedicle screws itself adds operative time, even with modern image-guided or robotic assistance [5]. In a public tertiary hospital in Pakistan, this additional time has tangible consequences, including longer anaesthesia, higher theatre costs, and greater physiological stress in older patients, and it reinforces the need for careful case selection before committing to fixation.

Pain outcomes favoured the fixation group at both time points. This is biologically plausible when an unstable, multilevel segment is rigidly stabilised. The direction of our result nonetheless contrasts with several high-quality trials. In the five-year results of the Swedish Spinal Stenosis Study, fewer patients in the fusion group reported reduced leg pain than did those in the decompression-alone group [13], and the Nordsten-DS trial found no advantage of added fusion for pain or disability [14]. The discrepancy probably reflects differences in case mix and follow-up: our cohort had multilevel disease and was assessed at 3 months, whereas the equivalence trials largely enrolled patients with single-level or low-grade disease followed for years. Notably, non-fusion stabilisation and endoscopic decompression achieve pain relief comparable to that of instrumented approaches in single-level disease [15], underscoring that the value of fixation is unlikely to be uniform across stenosis subtypes.

Disability also favoured fixation, with a lower mean ODI and a far higher proportion of patients reaching minimal disability (40.0% vs. 6.7%). This diverges from the larger randomized and pooled evidence. A recent randomized controlled trial found that decompression with motion-preserving facet arthroplasty outperformed decompression with fusion on disability and pain in single-level degenerative spondylolisthesis [16], the Nordsten-DS trial found decompression alone to be non-inferior to instrumented fusion at five years [14], and meta-analyses report no ODI difference between the two strategies at two years [7,8,9]. The most likely explanation for our stronger early benefit is that multilevel decompression carries a greater destabilising load than single-level surgery, so the protective effect of fixation is more visible in the short term. Whether this early advantage persists cannot be determined from a three-month study.

Radiological outcomes clearly favoured fixation, with bony fusion in 90.0% of Group B versus 60.0% of Group A and listhesis in only 3.3% versus 26.7%. This fits the biomechanical rationale that rigid pedicle-screw stabilisation promotes bone bridging and prevents segmental translation that can follow multilevel laminectomy, and that instrumented fusion has been shown to lower reoperation rates and to be cost-effective relative to uninstrumented techniques [17], with comparable interbody fusion rates across open and minimally invasive constructs [18]. A counterpoint deserves mention: Karlsson et al. found that adding fusion increased new stenosis on two-year MRI [19], a reminder that radiological stability and long-term canal patency are not the same thing. Motion-preserving and endoscopic techniques that limit facet resection achieve stability with high facet-joint preservation, indicating that durable stabilisation after decompression can be reached by more than one route [15,20].

Neurological improvement was also higher after fixation (93.3% vs. 66.7%). In multilevel LSS, residual deficits after surgery may stem not only from incomplete decompression but also from continuing instability-related traction on the neural elements. By restoring alignment and preventing listhesis, fixation may relieve traction and facilitate better recovery, providing a mechanistic account for the difference observed here.

Set against the major trials, our pro-fixation findings are best read through the lens of patient heterogeneity. The landmark recent trials enrolled predominantly single-level or low-grade degenerative spondylolisthesis [14,16], whereas our patients had multilevel disease in which the cumulative biomechanical effect of decompression across several segments creates a qualitatively different instability risk. Fusion is not without later cost, since adjacent-segment degeneration is a recognised sequela that can itself require further surgery [16,20]. It is also worth noting that less invasive options, such as unilateral biportal endoscopic decompression, are increasingly proposed to limit the very destabilisation that fixation is meant to counteract [21]; their role in multilevel disease remains to be defined.

This study has several limitations. Although allocation was randomised by lottery, with blinding of patients and outcome assessors, the operating surgeon could not be blinded because the two procedures differ in incision and postoperative imaging, leaving some scope for performance bias. The trial was conducted at a single centre, limiting generalisability, and the sample of 60 patients, while adequately powered for the primary outcome, was relatively small. The three-month follow-up captures early outcomes but cannot address long-term stability, implant-related complications, adjacent-segment disease, or the durability of neurological recovery. Fusion was assessed on plain radiographs rather than computed tomography to conserve resources and limit radiation exposure, even though computed tomography is more sensitive for solid fusion. Multicentre randomised trials with longer follow-up are needed to define the role of fixation in multilevel LSS more precisely, particularly in resource-limited health systems.

## CONCLUSIONS

In patients with multilevel lumbar spinal stenosis, decompressive laminectomy with transpedicular screw fixation was associated with better early pain relief, functional outcome, spinal stability, and neurological improvement than decompressive laminectomy alone, at the cost of a markedly longer operative time. These results should be weighed against larger trials of predominantly single-level disease that found decompression alone to be non-inferior. Taken

together, the evidence supports a selective approach in which fixation is reserved for patients at higher risk of postoperative instability, such as those with multilevel involvement, rather than applied routinely.

#### **PATIENTS' CONSENT:**

Informed consent from the patients or their legal guardians was taken before the assessment, and their anonymity was ensured throughout the research.

#### **COMPETING INTEREST:**

The authors declared no conflict of interest.

#### **FUNDING**

Not applicable

#### **AUTHORS CONTRIBUTION**

HU conceived the study, collected data, performed clinical assessment, and drafted the manuscript; MAK supervised the study, guided methodology, reviewed clinical interpretation, and critically revised the manuscript; AZ contributed to patient recruitment, data collection, clinical assessment, and manuscript review; ST contributed to patient recruitment, data collection, clinical documentation, and manuscript review; WA contributed to data collection, patient follow-up, clinical record review, and manuscript revision; JZ provided academic supervision, reviewed the final manuscript, and approved the final version for submission.

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