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Original Research Article

UNILATERAL VS BILATERAL STABILIZATION FOR LUMBAR DISC DISEASE: A FUNCTIONAL OUTCOME REVIEW

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ABSTRACT

Background: The necessity of bilateral stabilization following lumbar discectomy remains debated. Unilateral pedicle screw fixation has been proposed as a less invasive and cost-effective alternative with comparable biomechanical stability. The objective is to evaluate the clinical and functional outcomes of unilateral stabilization in patients with lumbar degenerative disc disease.

Materials and Methods: A prospective observational study was conducted on 39 patients with lumbar disc disease undergoing discectomy with unilateral pedicle screw fixation. Functional outcomes were assessed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) over a mean follow-up of 6 months. Operative parameters including duration of surgery and intraoperative blood loss were recorded.

Results: The mean operative time was 72 minutes, and mean blood loss was approximately 250 ml, with no requirement for blood transfusion. The mean ODI improved from 65.08 preoperatively to 14.67 at 6 months postoperatively. The mean VAS score improved from 6.56 to 2.30. No recurrences of symptoms or major complications were observed during follow-up.

Conclusion: Unilateral pedicle screw fixation provides significant functional improvement with reduced operative time, blood loss, and cost. It is an effective alternative to bilateral fixation in selected patients with lumbar degenerative disc disease without significant instability.

Keywords: lumbar disc disease; unilateral stabilization; pedicle screw fixation; functional outcome; ODI; VAS; spinal fusion.

INTRODUCTION

Lumbar disc disease is one of the most common causes of low back pain and radiculopathy, contributing significantly to morbidity in the working-age population.[8] It typically affects individuals between 30 and 50 years of age, with a higher prevalence in males. The most commonly involved levels are L4–L5 and L5–S1, where mechanical stress is greatest.

The intervertebral disc is a fibrocartilaginous structure composed of the nucleus pulposus, annulus fibrosus, and cartilaginous endplates. It functions as a shock absorber, distributing compressive forces across the vertebral column. Degeneration of the disc is a multifactorial process influenced by aging, genetic predisposition, nutritional factors, and environmental stresses such as repetitive mechanical loading and obesity.[7] Progressive degeneration may lead to disc prolapse, nerve root compression, and spinal instability.

Surgical intervention is indicated in patients with persistent symptoms, neurological deficits, or failure of conservative management.[8] Discectomy, performed through open, microsurgical, or endoscopic techniques, remains the standard procedure. However, the decision to add spinal stabilization following discectomy remains controversial. While bilateral pedicle screw fixation is widely accepted for providing rigid stabilization, it is associated with increased operative time, blood

loss, cost, and the potential for adjacent segment degeneration due to stress shielding.[1–3]

Unilateral pedicle screw fixation has been proposed as a less invasive alternative that may provide adequate stability while reducing surgical morbidity. Previous studies have demonstrated comparable fusion rates and clinical outcomes between unilateral and bilateral fixation, with additional benefits such as reduced operative time, decreased blood loss, and lower healthcare costs.[4–6,13,14] Furthermore, unilateral fixation may reduce the risk of adjacent segment degeneration by preserving physiological motion and minimizing stress shielding.[2,5]

Despite these potential advantages, the role of unilateral stabilization in lumbar disc disease is still under evaluation, particularly in terms of long-term functional outcomes and its effectiveness in preventing postoperative instability.[4,6]

The present study aims to evaluate the functional outcomes of unilateral pedicle screw fixation following lumbar discectomy and to assess whether it is a sufficient alternative to bilateral stabilization in selected patients with lumbar degenerative disc disease.

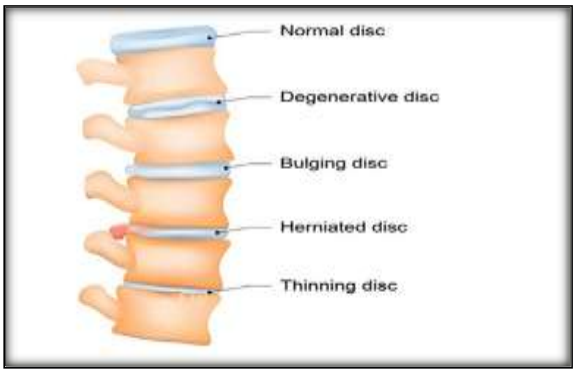

Figure 1: Stages of Lumbar Intervertebral Disc Degeneration

Figure Notes: This figure illustrates the progressive stages of lumbar intervertebral disc degeneration, beginning with a normal disc and advancing through degenerative changes, disc bulging, and herniation, ultimately leading to disc space narrowing and thinning. These structural changes may result in nerve root compression and contribute to clinical symptoms such as low back pain and radiculopathy.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective observational study conducted in the Department of Orthopaedics and Traumatology at Sri Venkateshwara Medcity.

Study Population: A total of 39 patients diagnosed with lumbar degenerative disc disease were included in the study.

- Age group: 30–65 years
- Sex distribution: 26 males and 28 females
- Mean follow-up duration: 6 months (range: 4–9 months)

Inclusion Criteria

1. Age between 30 and 65 years
2. Diagnosis of single-level lumbar disc disease confirmed clinically and radiologically
3. Presence of degenerative disc disease and/or spinal canal stenosis
4. Persistent low back pain with or without radiculopathy not responding to adequate conservative management
5. Previously ambulatory patients with good preoperative functional status
6. Patients fit for surgery under anesthesia
7. Willingness to undergo surgical intervention and regular follow-up

Exclusion Criteria

1. Multilevel lumbar disc disease with significant instability
2. Spondylolisthesis requiring bilateral stabilization
3. Previous lumbar spine surgery at the affected level
4. Spinal infection, Tumor, or malignancy
5. Severe spinal deformity (e.g., scoliosis, kyphosis)
6. Severe osteoporosis or medical comorbidities contraindicating surgery

Preoperative Evaluation: All patients underwent a comprehensive preoperative evaluation to establish the diagnosis and assess suitability for surgical intervention. A detailed clinical history was obtained, including the duration and severity of low back pain, presence of radiculopathy, and associated aggravating and relieving factors. This was followed by a thorough neurological examination assessing motor strength, sensory deficits, and deep tendon reflexes. Special clinical tests, including the Straight Leg Raising Test (SLRT) and femoral nerve stretch test, were performed to evaluate nerve root involvement.

Radiological assessment included plain radiographs of the lumbar spine to identify disc space narrowing, endplate sclerosis, osteophyte formation, and spinal alignment abnormalities. Magnetic resonance imaging (MRI) was performed in all cases to confirm the level and type of disc prolapse, degree of nerve root compression, and presence of associated spinal canal stenosis.

Baseline functional status was assessed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for pain. In addition, all patients underwent routine preoperative laboratory investigations and pre-anesthetic evaluation to determine fitness for surgery under general anesthesia.

Surgical Technique: All procedures were performed under general anesthesia with the patient in the prone position. A standard posterior midline approach was used to expose the affected lumbar level. After appropriate level confirmation, unilateral exposure of the lamina was carried out up

to the facet joint. Bilateral decompression was achieved by minimally extending the exposure as required.

Laminectomy was performed at the involved level, followed by careful discectomy to remove the herniated disc material and decompress the affected nerve roots. Adequate neural decompression was confirmed intraoperatively. Subsequently, unilateral pedicle screw fixation was performed using pedicle screws and a connecting rod on the affected side. Posterolateral bone grafting was then carried out to facilitate fusion.

Hemostasis was achieved, and the wound was closed in layers over a drain. All patients were shifted to the recovery unit in stable condition.

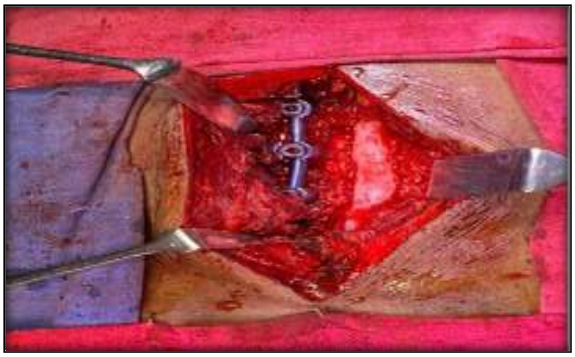

Figure 2: Intraoperative View of Unilateral Pedicle Screw Fixation.

Figure Notes: This intraoperative photograph demonstrates the posterior approach to the lumbar spine following decompression. Pedicle screws and a connecting rod are seen placed unilaterally after laminectomy and discectomy. The surgical field shows adequate exposure of the vertebral elements, with stabilization achieved on the affected side. This technique provides sufficient spinal stability while minimizing tissue dissection and operative morbidity.

Postoperative Care: All patients were monitored in the immediate postoperative period for hemodynamic stability and neurological status. Adequate pain control was achieved using standard analgesic protocols, and prophylactic antibiotics were administered as per institutional guidelines. Wound care was maintained with regular inspection and dressing changes, and surgical drains were removed once output was minimal.

Early mobilization was encouraged, with patients assisted to ambulate as tolerated, usually within the first few postoperative days. Physiotherapy was initiated to improve mobility, strengthen paraspinal muscles, and facilitate early return to functional activity. Patients were advised to avoid heavy lifting, excessive bending, and strenuous activities during the initial recovery period.

Follow-up evaluations were conducted at regular intervals, during which clinical assessment and functional outcomes were recorded using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS). Patients were monitored for any postoperative complications, recurrence of symptoms, or signs of instability.

Outcome Measures: The clinical and functional outcomes were evaluated using both subjective and objective parameters. Pain intensity was assessed using the Visual Analog Scale (VAS), while functional disability was measured using the Oswestry Disability Index (ODI). These scores were recorded preoperatively and at follow-up visits to assess the degree of improvement following surgery.

In addition to functional scores, operative parameters including duration of surgery, intraoperative blood loss, and the need for blood transfusion were documented. Postoperative recovery was assessed based on time to ambulation, length of hospital stay, and return to daily activities.

Patients were also monitored for complications, including infection, neurological deficits, implant-related issues, and recurrence of symptoms. Overall outcome was determined by comparing preoperative and postoperative clinical status along with functional improvement over the follow-up period.

Operative Parameters Recorded: The following intraoperative parameters were recorded for all patients:

- Duration of surgery (measured in minutes)
- Intraoperative blood loss (measured in milliliters)
- Requirement for blood transfusion, if any
- Level of surgery performed (e.g., L4–L5, L5–S1)
- Type of procedure performed (laminectomy with discectomy and unilateral fixation)

Statistical Analysis: Statistical analysis was performed using standard statistical methods. Continuous variables such as operative time, intraoperative blood loss, Oswestry Disability Index (ODI), and Visual Analog Scale (VAS) scores were expressed as mean ± standard deviation (SD). Preoperative and postoperative ODI and VAS scores were compared using the paired Student's t-test to assess the significance of functional improvement.

A *p-value* of <0.05 was considered statistically significant. Data analysis was performed using appropriate statistical software

Ethical Considerations: The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee prior to commencement of the study. All patients were informed in detail about the nature of the procedure, potential risks, and benefits, and written informed consent was obtained from all participants before inclusion in the study.

Patient confidentiality was strictly maintained, and all data were anonymized during analysis. Participants were assured that refusal to participate would not affect their treatment, and they were free to withdraw from the study at any stage without any consequences.

RESULTS

A total of 39 patients with lumbar degenerative disc disease underwent discectomy with unilateral pedicle screw fixation and were followed up for a mean duration of 6 months (range: 4–9 months). The study population included patients in the age group of 30–65 years, comprising both males and females.

Operative Parameters: The intraoperative parameters were recorded for all patients to assess the efficiency and safety of the procedure. The mean duration of surgery was 72 minutes, and the average intraoperative blood loss was approximately 250 ml. None of the patients required intraoperative or postoperative blood transfusion. The procedures were performed at single lumbar levels, most commonly involving L4–L5 and L5–S1 segments. These findings indicate that unilateral stabilization is associated with reduced operative time and minimal.

Table 1: Intraoperative Parameters in Patients Undergoing Unilateral Stabilization

Parameter	Value
Mean operative time	72 minutes
Mean blood loss	250 ml
Blood transfusion	Nil

Notes: Values are presented as mean values. Operative time is expressed in minutes, and intraoperative blood loss is expressed in milliliters. No patients required intraoperative or postoperative blood transfusion.

Functional Outcomes: Functional outcomes were assessed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for pain. A marked improvement was observed in both parameters following surgical intervention. The mean ODI score decreased significantly from 65.08 preoperatively to 14.67 at 6 months postoperatively, indicating substantial improvement in functional disability. Similarly, the mean VAS score showed a significant reduction from 6.56 preoperatively to 2.30 at final follow-up, reflecting effective pain relief.

Overall, all patients demonstrated significant clinical improvement with enhanced functional capacity and reduction in pain. The majority of patients achieved early ambulation and were able to return to their daily activities without significant limitations.

Table 2: Comparison of Preoperative and Postoperative Functional Outcome Scores

Parameter	Preoperative	Postoperative (6 Months)
ODI Score (Mean)	65.08	14.67
VAS Score (Mean)	6.56	2.30

Notes: Values are presented as mean scores. Functional outcomes were assessed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS). Postoperative scores represent evaluation at 6 months follow-up. A reduction in ODI and VAS scores indicates improvement in functional status and pain relief following surgery.

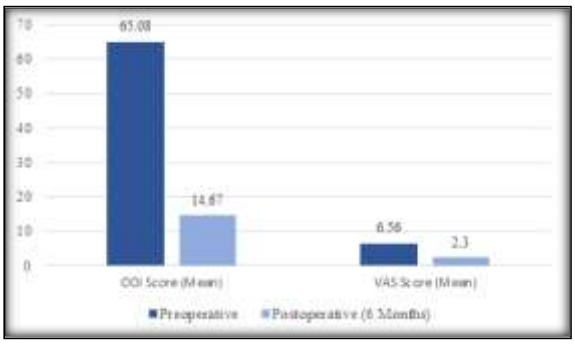

Figure 2: Preoperative vs Postoperative Functional Outcome Comparison (ODI and VAS)

Figure Notes: This figure demonstrates the comparison of preoperative and 6-month postoperative functional outcomes using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS). A marked reduction in both ODI and VAS scores is observed postoperatively, indicating significant improvement in pain relief and functional status following unilateral pedicle screw fixation.

Operative Parameters: The intraoperative parameters were recorded for all patients to assess the efficiency and safety of the procedure. The mean duration of surgery was 72 minutes, and the average intraoperative blood loss was approximately 250 ml. None of the patients required intraoperative or postoperative blood transfusion. The procedures were performed at single lumbar levels, most commonly involving L4–L5 and L5–S1 segments. These findings indicate that unilateral stabilization is associated with reduced operative time and minimal blood loss.

Table 3: Postoperative Complications Following Unilateral Stabilization

Complication	Number of Cases
Wound infection	0
Neurological deficit	0
Implant failure	0
Recurrence	0

Notes: Values are presented as number of cases. No major intraoperative or postoperative complications were observed. There were no cases of wound infection, neurological deficit, implant failure, or recurrence during the follow-up period, indicating a low complication rate associated with the procedure

Figure 3: Postoperative Radiographs Showing Unilateral Pedicle Screw Fixation

Figure Notes: Anteroposterior (left) and lateral (right) radiographic views of the lumbar spine demonstrating unilateral pedicle screw fixation at the affected level. The images confirm appropriate placement of pedicle screws and connecting rod, restoration of spinal alignment, and stabilization following decompression and discectomy.

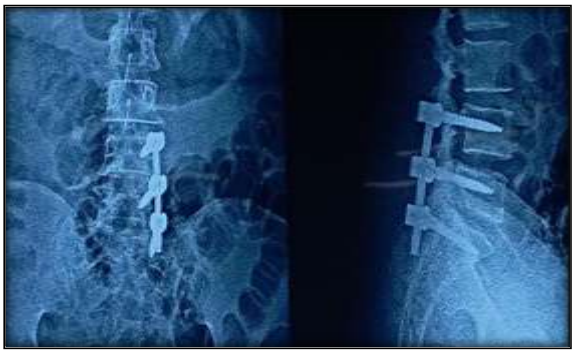

Figure 4: Postoperative Radiographic Evaluation of Unilateral Pedicle Screw Fixation

Figure Notes: Anteroposterior (left) and lateral (right) radiographic views of the lumbar spine demonstrating unilateral pedicle screw fixation. The images show proper positioning of pedicle screws and connecting rod with maintained spinal alignment and adequate stabilization at the operated level. No evidence of implant loosening or malposition is observed.

DISCUSSION

The role of spinal stabilization following lumbar discectomy remains a subject of ongoing debate. While bilateral pedicle screw fixation is traditionally considered the gold standard for achieving rigid stabilization, it is associated with increased operative time, higher blood loss, greater cost, and a potential risk of adjacent segment degeneration due to stress shielding.[1–3]

In contrast, unilateral pedicle screw fixation has emerged as a less invasive alternative that aims to provide adequate stability while minimizing surgical morbidity. Biomechanically, unilateral fixation offers sufficient stabilization for single-level lumbar degenerative pathology while preserving a degree of physiological motion.[4–6] This reduced rigidity may help decrease the incidence of adjacent segment degeneration, which is often attributed to altered load distribution following rigid bilateral fixation.[2,5]

Previous studies have demonstrated comparable clinical outcomes between unilateral and bilateral fixation. Kabins et al. reported that unilateral instrumentation yields results nearly identical to bilateral fixation,[1] while Goel et al. highlighted its potential to reduce stress shielding and adjacent segment degeneration.[2] Additionally, several comparative studies and meta-analyses have shown that unilateral fixation significantly reduces operative time, intraoperative blood loss, duration of hospital stay, and overall medical expenses without compromising fusion rates or functional outcomes.[4–7,13,14]

The findings of the present study are consistent with the existing literature. There was a significant improvement in both ODI and VAS scores, indicating substantial reduction in pain and disability following unilateral stabilization. The mean operative time (72 minutes) and average blood loss (approximately 250 ml) were relatively low, further supporting the minimally invasive nature of this technique.[6,12] Moreover, no major complications or recurrence of symptoms were observed during the follow-up period, suggesting that unilateral fixation is a safe and reliable procedure in selected patients.[7,15]

An additional advantage observed in this study was the cost-effectiveness of unilateral stabilization, as it involves fewer implants compared to bilateral fixation. This is particularly relevant in resource-limited settings, where reducing the economic burden of surgery is an important consideration.[4,6]

However, certain limitations must be acknowledged. The study had a relatively small sample size and a short follow-up duration of 6 months, which may not fully capture long-term outcomes such as fusion rates and adjacent segment degeneration. Furthermore, the absence of a direct comparison group undergoing bilateral fixation limits the ability to draw definitive comparative conclusions.[4,5]

CONCLUSION

Unilateral pedicle screw fixation is an effective and reliable method of stabilization in selected patients with lumbar degenerative disc disease. It provides significant improvement in pain and functional outcomes, with results comparable to bilateral

fixation. Additionally, it offers important advantages such as reduced operative time, decreased intraoperative blood loss, shorter hospital stay, and lower overall cost.

Unilateral stabilization represents a balanced approach, providing adequate spinal stability while minimizing surgical morbidity. It can be considered a safe and cost-effective alternative to bilateral fixation in cases without significant spinal instability.

Further studies with larger sample sizes and longer follow-up are recommended to evaluate long-term outcomes and fusion rates.

Limitations: This study has several limitations. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the follow-up period was short (mean of 6 months), and therefore long-term outcomes such as fusion rates, implant longevity, and adjacent segment degeneration could not be adequately assessed. Third, the study lacked a control or comparison group undergoing bilateral fixation, which restricts direct comparative analysis between the two techniques. Additionally, advanced statistical analyses and subgroup evaluations were not performed.

Further prospective, randomized studies with larger sample sizes and longer follow-up durations are required to validate these findings and establish the long-term efficacy of unilateral stabilization.

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