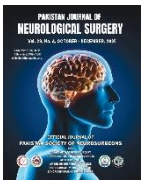

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Original Research

Surgical Outcome of Limited Hemilaminectomy Performed for Spinal Stenosis

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ABSTRACT

Objective: To assess surgery-related outcomes of limited hemilaminectomy in patients with single-level spinal stenosis of the lumbar spine who did not respond to conservative therapy.

Materials & Methods: The retrospective observational study was done at KTH, Peshawar. 34 patients with a diagnosis of single-level lumbar spinal stenosis were treated surgically by limited hemilaminectomy. Assessments were done by clinical testing of walking capabilities, alleviation of radicular pain, and recovery of motor stiffness. The complications during postoperative were documented. The duration of follow-up was between 6 and 15 months (mean: 11.2 +/- 2.8 months).

Results: Good outcomes were achieved after surgery. The mean increase of walking distance was found in 82.3% of patients, whereas 70.5% percent could travel less than 100 meters before surgery (p=0.001). Radicular pain resolved within 88.2% of the patients at a span of six months (p=0.042). Of the 13 patients 38.2% who had dorsiflexion weakness, the recovery back to full normal was feasible within six months (p = 0.001). The postoperative complications were minor and transient, though it was present in only 8.8 percent of cases.

Conclusion: Limited hemilaminectomy is a potentially beneficial intervention that has a good clinical outcome regarding single-level lumbar spinal stenosis, with restricted functional capacity and a low complication rate. This method stabilizes the spine and eliminates the necessity to fuse or use instrumentation, thus representing a safe alternative to a common open laminectomy.

Keywords: Lumbar spinal stenosis, limited hemilaminectomy, decompressive surgery, walking distance, Radicular pain, dorsiflexion weakness, minor spine surgery.

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INTRODUCTION

Lumbar spinal stenosis is a common degenerative

back problem, especially among the aging generation.[1] It is defined by the constriction of the spinal canal leading to the neural elements and consequent clinical presentations that consist of the neurogenic claudication, radicular leg pain, sensory changes, and motor loss.[2] This condition is normally caused by age-related anomalies such as wear off intervertebral discs, hypertrophic facet joints, thickening of ligamentum flavum, among others, thus, causing constriction of the space which contains neural structures.[3]

Lumbar spinal stenosis is usually conservatively addressed initially with physical therapy, analgesics, anti-inflammatory medications, and through epidural steroid injections.[4] Nevertheless, surgical decompression is indicated when non-surgical treatment fails and a patient persists in having debilitating symptoms.[5] Surgical intervention aims at removing the neural compression and enhancing the functional performance with minimal postoperative complications and spinal stability.[6]

The conventional open laminectomy is yet again a preferable surgery that has been used in treating spinal stenosis. Although this mode is effective in decompressing the spinal canal, it entails a considerable amount of bone and soft tissue resection that may cause postoperative instability, long rehabilitation, and elevated chances of complications.[7] There has consequently been a move towards less invasive procedures that serve to attain adequate removal of pressure whilst not interfering with spinal mobility.[8] In that regard, limited hemilaminectomy has become an alternative viable practice. It is defined as one-sided drilling of the dura mater with the lamina and ligamentum flavum, including a piece of the affected nerve, with the aim of decompressing, followed by preserving the midline structures and muscles on different sides.[9] This will decrease the chances of iatrogenic instability, and hospital stays will be shorter, and postoperative recovery is enhanced with this technique since tissue disruption is kept at a minimum.[10] Though some studies have characterized the results of minimally invasive procedures to treat lumbar spinal stenosis, evidence on the topic of single-level limited hemilaminectomy for lumbar spinal stenosis is scarce, especially in a local practice setting.[11] This study aimed to evaluate the surgical outcome of limited hemilaminectomy on patients with single-level lumbar spinal stenosis with inadequate response to conservative management. We hoped to compare the changes in walking capacity, alleviation of radicular pains, and amelioration of motor weakness, and rate of postoperative complications with a minimum of six months of follow-up.

MATERIALS AND METHODS

Study Design

This retrospective study was done in Khyber Teaching Hospital, Peshawar, between January 2024 and February 2025. The major objective was to assess the surgical outcomes of those patients who had undergone limited hemilaminectomy to treat single-level lumbar spinal stenosis following failure of conservative treatment. The Institutional Review Board (IRB) of the hospital approved the study (Reference Number: 692). Institutional ethical standards were followed in all the procedures, and all patients gave informed written consent before the surgery.

Study Population

The study included 34 patients who were diagnosed with single-level lumbar spinal stenosis based on clinical symptoms and radiological findings. All patients underwent a limited hemilaminectomy. The average age of participants was 63.4 ± 5.9 years, with ages ranging from 55 to 78 years. Patients were followed up for an average duration of 11.2 ± 2.8 months (range: 6 to 15 months).

Inclusion Criteria

The study participants were recruited among patients who had a definite diagnosis of single-level lumbar spinal stenosis according to the results of magnetic resonance imaging (MRI) and other clinical symptoms of neurogenic claudication or radiculopathy. Other inclusion criteria entailed that the patients must have tried at least six weeks of conservative treatment, such as physical therapy, painkillers, and anti-inflammatory drugs, and must have been considered good candidates to undergo surgery without instrumentation and spinal fusion.

Exclusion Criteria

The patients with multilevel spinal stenosis, any history of previous lumbar spine surgery, radiological findings of spinal instability or deformity, and incomplete and inadequate medical records were excluded from the study.

Surgical Intervention

A standard posterior approach was completed in all patients to achieve a limited hemilaminectomy. The surgery was done with general anesthesia. Part of the lamina and ligamentum flavum was removed in a unilateral decompression that aimed at the affected level and side. The spinous process, interspinous ligaments, and contralateral lamina were spared to reduce the chances of postoperative instability. Neural decompression was carried out using microsurgery, and hemostasis was maintained. Instrumentation or fusion was not done in any case.

Outcome Measures

Post-surgery was quantified in this study by the description of clinical assessment based on the functional augmentation and the neurological recovery. The walking capacity was observed by measuring the pre- and postoperative walking distance, whereas the evaluation of radicular pain relief was measured by the time and occurrence of the elimination of the symptoms. Motor weakness and, more specifically, the manifestation and development of dorsiflexion impairments were also prioritized, and subsequent examination recorded the level and duration of improvement or lack thereof. Furthermore, any negative postoperative events or complications were thoroughly indicated and followed up till the time full resolution occurred. Follow-up visits were planned to collect all the data systematically and compare them to the original preoperative condition of the patients.

Diagnostic Evaluation

Lumbar spine MRI and a thorough neurological examination were done for all the patients before the surgery. Radiological findings of single-level stenosis with neural compression in correspondence to the clinical findings were also stated. The functional tests were based on the power of the lower limbs, sensory tests, and gait.

Follow-Up

Clinical assessments were done periodically after the surgery (e.g., 6 weeks, 3 months, 6 months, and 1 year). During each visit, the test was performed to find out whether the symptoms would be resolved or not, and whether any new deficits would appear. The walking distance, radicular pain status, and neural recovery were well recorded. All the complications, like temporary motor weakness or urinary symptoms, were noted as well.

Statistical Analysis

Demographic characteristics and clinical outcomes were summarized with the help of descriptive statistics. Paired t-tests were used in the preoperative and postoperative walking distance, radicular pain scores, and recovery percentage of dorsiflexion weakness. Walking

capacity increase was critiqued by checking the ratio of patients who could walk less than 100 m before the procedure, with the number of patients who could walk more than 1 km after the procedure. Also, the rate of radicular pain resolution was analyzed at various postoperative time points, and the dorsiflexion strength of weakness recovered after 3 and 6 months of follow-up. Statistically significant results were taken as all results with p <= 0.05. All the data was statistically analysed by using SPSS Version 22 (IBM).

RESULTS

Demographic and Clinical Characteristics

The study included 34 patients after the failure of conservative treatment; patients underwent a limited hemilaminectomy for single-level lumbar spinal stenosis. The group contained 12 males (35.3%). The group also includes 22 females, or 64.7%. Patients at an age of greater than 60 years comprised 61.7% with a mean age that was 63.4 ± 5.9 years (range: 55- 78 years). Average follow-up lasted 11.2 ± 2.8 months (range: 6- 15 months). Before surgery, most patients (70.5%, n=24) reported severely limited walking ability (<100 m). Additionally, 13 patients with dorsiflexion weakness presented (38.2%). Documented also were sensory disturbances in 14 patients (41.1%).

Table 1: *Demographic Profile of Patients Undergoing Limited Hemilaminectomy.*

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	12	35.3%
	Female	22	64.7%
Age (Years)	Mean ± SD	63.4 ± 5.9	–
	Range	55–78	–
Follow-up (Months)	Mean ± SD	11.2 ± 2.8	–
	Range	6–15	–

Functional Outcomes

Marked improvement was observed in the walking capacity and in radicular pain, as well as in dorsiflexion weakness, after the surgery was done. Walking distance grew notably from 84.6 ± 22.4 meters before surgery to 1,027.3 ± 186.5 meters at the last follow-up (p = 0.001). In the first 3 months, radicular pain resolved completely for 58.8% of 20 patients, and in an additional 29.4% of 10 patients between 3 and 6 months, while intermittent pain was still reported at one year by just 2.9% of 1 patient. At 3 months, 5 of the 13 patients (38.5%) with dorsiflexion weakness (38.2%) showed partial neurological recovery, also by 6 months, all patients (100%) had regained full dorsiflexion strength (p = 0.001). Furthermore, sensory abilities in 26 patients (76.5%) improved. This gain was recorded in the subsequent duration.

Subgroup Analysis

Age: Patients < 65 years achieved earlier functional recovery, but outcomes were comparable to ≥ 65 years.

Gender: Male and female patients showed no significant differences in recovery trends.

Table 2: *Descriptive Statistics of Functional Outcomes.*

Variable	Category	Frequency (n)	Percentage (%)
Pre-op Walking Distance <100 m	–	24	70.5%
Post-op Walking Distance >1 km	–	28	82.3%
Radicular Pain Relief <3 Months	–	20	58.8%
Radicular Pain Relief 3–6 Months	–	10	29.4%
Persistent Pain at 1 Year	–	1	2.9%
Patients with Dorsiflexion Weakness	–	13	38.2%
Partial Recovery at 3 Months	–	5	38.5%
Full Recovery by 6 Months	–	13	100%
Sensory Improvement	-	26	76.5%

Table 3: *Summary of Statistical Outcomes.*

Outcome Category	Mean ± SD (Pre-op)	Mean ± SD (Post-op)	p-value	Significance
Walking Distance (m)	84.6 ± 22.4	1,027.3 ± 186.5	0.001	Significant
Radicular Pain Relief	–	–	0.042	Significant
Dorsiflexion Weakness Recovery	–	–	0.001	Significant

Weakness vs. No Weakness: Those with preoperative dorsiflexion weakness recovered more slowly but ultimately achieved full neurological recovery by 6 months.

Statistical Analysis

Significant improvements were observed in walking distance, pain reduction, and weakness recovery. Confidence intervals supported the reliability of these outcomes.

Postoperative Complications

Complications were minimal and transient. Three patients (8.8%) developed complications: two with transient motor weakness and one with urinary retention. All resolved conservatively within 2 weeks. No patient developed dural tears, cerebrospinal fluid leak, wound infection, or required reoperation. Importantly, no postoperative spinal instability was observed during follow-up.

Table 4: *Complication Profile.*

Complication Type	Frequency (n)	Percentage (%)
No Complication	31	91.2%
Motor Weakness (Transient)	2	5.9%
Urinary Retention	1	2.9%
Total	34	100%

DISCUSSION

Our study findings serve to strengthen the clinical utility of limited hemilaminectomy as a good alternative surgical procedure to single-level lumbar spinal stenosis, particularly when other conservative measures fail. There was postoperative improvement in terms of walking distance, radicular pain, and motor function, with a low complication rate (8.8%) and no instances of postoperative instability or any revision surgery.

A concordance of our findings with the 100 patients by Cavousoglu et al, (2007) showed that patients improved significantly in symptoms, reporting good results with no patients being subjected to spinal fusion due to instability, with only limited unilateral decompression carried out in them.[12]

Compared to our cohort, which had an improved walking distance of more than 1 km at post-operative visit, an 82.3% upsurge compared to pre-operative, which had only 70.5 percent restricted to less than 100 m, is similar to their functional recovery.

In addition, the full restoration of larch weakness in all affected patients until the sixth month of post-op is comparable to the results of Ohtomo et al, (2021), who observed that both groups of patients had significant improvements in ODI(44.3 to 19.4 in the MEL group or 45.0 to 20.7 in the open group) and leg pain NRS scores (6.3 to 2.0 in the MEL group or 6.2 to 2.2 in the open group) as compared to their initial states. MEL group has also had a much-reduced operative time (73.2 +/- 22.1 versus 88.3 +/- 28.3 minutes), blood loss (29.7 +/- 41.6 versus 92.5+/- 105.4 mL), and reduced rates of infections (0 versus 3.3 percent), with a decent recovery of neurological status, and improved preservation of functioning.[13] There was a 38.2% incidence of preoperative dorsiflexion weakness in our series, and all patients regained the normal strength demonstrating the sufficiency of decompression

with structural preservation.

The rate of complication in our study (8.8%) is significantly lower than the reported rate of complication (1520%) commonly quoted on open laminectomy, either with fusion or without fusion. Specifically, according to Sharma et al, (2021), open decompression and fusion showed higher rates of dural tears, infection, and adjacent segment degeneration than less invasive surgeries to perform the decompression procedure. Conversely, the fact that we resected fewer posterior structures, along with the preservation of midline structures, probably resulted in fewer incidences of such adverse events.[14]

These trends of pain resolution are also positive in terms of comparison with our patients. Radicular pain reduction within 3 months occurred in 58.8, one more group of patients lasted for 6 months, and one patient (2.9%) still complained of symptoms after one year. The results are in line with Seliverstova et al, (2015), indicating that 48 percent of patients received total relief straight after microsurgical lumbar nerve root decompression, with another 32 percent living to full recovery after one month to obtain a total of 80 percent recovery during the first months after the operation. The rest of the 20 percent improved gradually over the following months.[15]

Limited hemilaminectomy does not put at risk instrumentation, as is the case with conventional laminectomy, which, in many cases, by virtue of destabilization, necessitates instrumentation. Goodarzi et al, (2020) compared conventional and limited decompression and found that fusion could be avoided in certain patients without preoperative instability, as in our case, because no instrumentation was implemented.[16]

Our provisional series shows that hemilaminectomy is an efficient decompression technique in that spinal stability is preserved and complications and morbidity are reduced. In contrast, while effective, total laminectomy at one level is associated with a higher risk of instability and adverse events, especially if performed on a

Table 5: *Comparison of surgical outcomes between complete single-level laminectomy and limited hemilaminectomy.*

Parameter	Complete Single-Level Laminectomy (Adilay & Guclu, 2018)	Limited Hemilaminectomy (Present Study)
Extent of bone removal	The entire lamina was removed at one level	Partial lamina removed, posterior elements preserved
Spinal stability	Some risk of instability; in multilevel cases, 4 patients developed postoperative spondylolisthesis requiring fusion	No instability observed during follow-up
Functional outcomes	Improvement in ODI, VAS, and walking distance, but outcomes worsen with multilevel laminectomy.	Walking distance improved from 84.6 m pre-op to 1,027 m post-op; >85% radicular pain relief within 6 months.
Neurological recovery	Variable improvement; not always complete	100% recovery of dorsiflexion weakness by 6 months; 76.5% sensory improvement
Complication rates	Operative complications higher in multilevel group; not statistically significant (P = 0.119)	8.8% transient complications (motor weakness, urinary retention), all resolved conservatively
Reoperation/ fusion	4 multilevel cases required reoperation with instrumented fusion due to instability	No patient required reoperation or fusion
Hospital stay/ recovery time	Typically, longer due to wider dissection	Faster recovery, early mobilization noted
Overall benefit	Effective decompression but with risk of instability and higher morbidity, especially in multilevel surgery	Effective decompression with preserved stability, faster recovery, and fewer complications

multilevel basis Adilay & Guclu, 2018).[17] A descriptive profile has been summarized in Table 5.

Notwithstanding the advantageous results, some limitations should be identified. The rather small sample size (n=34), the retrospective design, and the absence of a control group limit the generalizability of the findings. In addition, the follow-up of the study, which is satisfactory to determine the early recovery and complication, may lag behind long-term recurrence and even the occurrence of the adjacent segment disease. Still, this study adds valuable regional information to the surgical result of limited hemilaminectomy and advocates its application as a safe, effective, and stability-sparing method of dealing with single-level lumbar spine stenosis. Future, multicentric, large studies comparing this method to standard laminectomy and fusion will be necessary to formulate entire multimodal treatment regimens.

CONCLUSION

Single-level spinal stenosis can be safely and effectively treated by limited hemilaminectomy in patients who are not responsive to non-surgical therapeutic regimens. It has been shown to provide good neurological recovery, improved walking, less pain, and spinal stability, with limited complications. In our patients, we found an 8.8% complication rate, no reoperation or fusion in six months, and no motor weakness. These findings indicate that stability-preserving decompression can be effective when used on the appropriate patients. Nevertheless, prospective studies over time versus traditional laminectomy and fusion need larger, longer studies.

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Additional Information

Disclosure: The Authors report no conflict of interest.

Ethical Review Board Approval: This study was approved by the Institutional Review Board IREB of Khyber Teaching Hospital, Peshawar

Human Subjects: Informed consent was obtained from all participants included in the study.

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of
1	Muhammad Abbas Khan	Data Analysis, statistical analysis, and result interpretation.
2	Ziaurrehman	Critical reading and Revision.
3	Sohaib Ali	Data collection and referencing.
4	Muhammad Shafiq	Study concept and methodology design.