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Article

Surgical and Nonsurgical Treatment for Lumbar Spinal Stenosis: Three Years' Experience in Sandeman Teaching Hospital Quetta

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ABSTRACT

Background: Lumbar spinal stenosis (LSS) is a prevalent degenerative condition among older adults, frequently leading to chronic pain and functional impairment. Despite advances in both surgical and non-surgical treatments, there remains limited region-specific evdence regarding their comparative effectiveness, especially in resource-limited settings. **Objective:** This study aimed to compare the outcomes of surgical interventions and non-surgical management strategies for LSS in terms of pain relief, functional improvement, and healthcare resource utilization among patients treated at a tertiary care center. **Methods:** This retrospective cohort study included 250 patients (n = 250) diagnosed with LSS at Sandeman Teaching Hospital Quetta from March 2022 to February 2024. Inclusion criteria comprised adults aged ≥50 years with radiologically and clinically confirmed LSS; patients with incomplete records or prior unrelated spine surgery were excluded. Data on demographics, comorbidities, treatment modalities, and outcomes were collected via electronic medical records. Pain and disability were assessed using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), respectively. Statistical analysis was performed using SPSS 27.0, employing t-tests, ANOVA, chi-square, and regression analysis. The study received ethical approval from the Institutional Review Board, following the Helsinki Declaration. **Results:** Of 250 patients, 150 underwent surgical treatment and 100 received non-surgical management. Surgical patients exhibited greater improvement in pain (post-treatment VAS: 3.1 ± 1.0 vs. 6.5 ± 1.2, $p < 0.001$) and function (post-treatment ODI: 34.2 ± 4.2% vs. 54.7 ± 6.1%, $p < 0.001$). Odds of clinically significant pain relief were higher with surgery (OR = 3.5, 95% CI: 2.1–5.9). Surgical intervention was associated with increased initial resource utilization but better long-term outcomes. **Conclusion:** Surgical treatment provides superior pain relief and functional recovery compared to non-surgical strategies in LSS, supporting its use in patients with severe symptoms while highlighting the value of individualized treatment planning and healthcare resource allocation in clinical practice.

Keywords: Lumbar Spinal Stenosis; Decompressive Laminectomy; Physical Therapy Modalities; Pain Management; Functional Recovery; Healthcare Utilization; Retrospective Studies.

INTRODUCTION

Lumbar spinal stenosis (LSS) represents a prevalent degenerative condition, especially among elderly individuals, characterized by the narrowing of the spinal canal which often results from arthritic changes (1). This anatomical constriction can lead to compression of neural elements, producing a clinical syndrome that includes chronic lower back pain, radiculopathy, and the hallmark symptom of neurogenic claudication—pain or discomfort in the legs exacerbated by walking or standing and alleviated by sitting or lumbar flexion (2-4). Advances in imaging modalities such as MRI and CT have heightened diagnostic accuracy, contributing to an increased recognition of LSS, now among the most common indications for spine surgery in those over 65 years old (5-7). Despite this rise in diagnosis, treatment strategies remain a subject of considerable debate, as both surgical and non-surgical options are widely employed. Notably, while overall rates of LSS surgery have decreased modestly, the frequency of complex surgical interventions, including spinal fusion, has grown, further amplifying the economic impact of managing this condition (8-10).Previous literature underscores the significant

burden LSS places on healthcare systems globally, particularly as the population ages and the prevalence of severe forms of LSS escalates with advancing age, reaching over 20% among octogenarians (11). This epidemiological trend necessitates evidence-based approaches to optimize patient outcomes and resource allocation. While surgical procedures such as decompressive laminectomy and minimally invasive techniques have been shown to provide substantial relief from pain and disability by addressing the underlying neural compression, non-surgical management—including physical therapy, pharmacological interventions, and epidural steroid injections—remains pivotal, particularly for patients with milder symptoms, substantial comorbidities, or those who decline operative treatment (12-13). However, the relative effectiveness of these divergent strategies, especially in real-world settings, is still under investigation, with some studies suggesting surgery yields superior functional improvement, albeit with higher upfront healthcare resource utilization and cost (14-17).

In light of these considerations, the current body of evidence highlights the need for context-specific analyses that compare surgical and non-surgical interventions using contemporary cohorts. Particularly in resource-constrained environments, such as peripheral tertiary care centers, it is critical to establish whether the incremental benefits of surgery justify the greater initial investment in terms of hospitalization and perioperative care or whether conservative management can yield acceptable outcomes in selected patient populations (18-24). Despite prior research, there is limited data from regional teaching hospitals on the comparative outcomes of these approaches, leaving a knowledge gap regarding optimal treatment paradigms in such settings.

Therefore, this retrospective study aims to evaluate and compare the outcomes of surgical and non-surgical treatment modalities for lumbar spinal stenosis over a three-year period at Sandeman Teaching Hospital Quetta. The objective is to determine which approach offers superior pain relief, functional improvement, and cost-effectiveness, thereby providing evidence to inform treatment selection and healthcare planning for this increasingly common and impactful condition.

MATERIALS AND METHODS

This retrospective cohort study was conducted in accordance with the STROBE guidelines to ensure rigorous reporting of observational research (1). The research was carried out at the Department of Neurosurgery Unit 1, Bolan Medical College, Sandeman Teaching Hospital Quetta, spanning from March 1, 2022, to February 28, 2024. Patients included in this study were identified via electronic medical records (EMRs) and were required to have a diagnosis of lumbar spinal stenosis confirmed by clinical assessment and imaging studies such as MRI or CT scans, consistent with established diagnostic criteria. Eligible participants were adults aged 50 years or older who exhibited symptoms compatible with lumbar spinal stenosis and received either surgical or non-surgical treatment modalities within the study period. Exclusion criteria included incomplete clinical records, ambiguous treatment data, prior spinal surgery for other indications, or follow-up less than twelve months, to minimize bias and improve data integrity. Participant recruitment was based on comprehensive EMR review; informed consent was obtained retrospectively where feasible, adhering to institutional ethical standards and protecting patient confidentiality in accordance with the Declaration of Helsinki. Ethical approval for the study protocol was obtained from the Institutional Review Board (IRB) of Bolan Medical College and Sandeman Teaching Hospital prior to data extraction and analysis.

Data collection entailed systematic abstraction of demographic characteristics (age, gender, BMI), baseline clinical parameters (duration and severity of symptoms, comorbidities such as diabetes and hypertension), as well as treatment-specific information including type of surgical intervention (decompressive laminectomy, microendoscopic discectomy, percutaneous laminotomy) or non-surgical regimen (physical therapy, pharmacotherapy, epidural steroid injections), and associated details such as dosage, frequency, and therapy duration. Baseline and post-treatment outcome measures were extracted, including the Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI) for functional impairment, hospital admission frequency, length of stay, and number of rehabilitation sessions. Follow-up was conducted through scheduled outpatient visits, EMR review, and telephone interviews as necessary to ensure completeness of outcome ascertainment.

The primary outcome measures were the degree of pain reduction (change in VAS) and functional improvement (change in ODI) at last follow-up. Secondary outcomes included healthcare resource utilization (hospital admissions, length of stay, rehabilitation sessions) and the occurrence of adverse events or surgical complications. All assessments were conducted using standardized tools with previously established validity and reliability for LSS outcomes.

Statistical analysis was performed using SPSS version 27.0. Continuous variables were summarized as means with standard deviations, and categorical variables as frequencies or percentages. Comparative analyses between the surgical and non-surgical groups employed independent t-tests for continuous outcomes and chi-square tests for categorical variables. Multivariable regression models were developed to adjust for potential confounding factors, including age, gender, baseline pain/disability, and comorbidities. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for key outcomes. Missing data were addressed using multiple imputation, with sensitivity analyses performed to assess the robustness of findings. All results were reported with two-sided p-values, with statistical significance set at $p<0.05$. References in this manuscript are cited in Vanocur style, with relevant literature supporting methodological and analytical choices (1).

RESULTS

A total of 250 patients diagnosed with lumbar spinal stenosis (LSS) were included in the retrospective analysis, with 150 patients allocated to the surgical group and 100 to the non-surgical group. The surgical cohort had a mean age of 65.4 ± 7.2 years, whereas the non-surgical group's mean age was 67.8 ± 6.5 years. Males comprised 60% of both cohorts. The average

follow-up duration across both groups was 2.5 ± 0.8 years. Complete outcome data were available for all enrolled participants; missing data were minimal and addressed through multiple imputation, with no substantial differences observed on sensitivity analyses. The surgical group predominantly underwent decompressive laminectomy (75%), followed by microendoscopic discectomy (15%) and percutaneous laminotomy (10%). In the non-surgical group, 50% received structured physical therapy, 30% received epidural steroid injections, and 20% were managed with pharmacological treatments, including NSAIDs and muscle relaxants. A statistically significant difference was observed in the distribution of treatment modalities between the two groups (χ^2 = 18.2, df = 1, $p < 0.001$; Table 5).

Table 1. Distribution of Treatment Modalities Among Study Groups

Treatment Modality	Surgical Group (%)	Non-Surgical Group (%)
Decompressive Laminectomy	75	-
Microendoscopic Discectomy	15	-
Percutaneous Laminotomy	10	-
Physical Therapy	-	50
Epidural Steroid Injections	-	30
Pharmacological Treatments	-	20

Both groups reported high baseline pain and disability, with pre-treatment VAS scores of 8.2 ± 1.5 (surgical) and 8.0 ± 1.3 (non-surgical), and pre-treatment Oswestry Disability Index (ODI) scores of 70.1 ± 5.6% and 68.5 ± 4.8%, respectively. Post-treatment, the surgical group demonstrated substantially greater improvements: mean VAS decreased to 3.1 ± 1.0, while the non-surgical group reached 6.5 ± 1.2. Likewise, mean ODI improved to 34.2 ± 4.2% in the surgical group and to 54.7 ± 6.1% in the non-surgical group. Analysis of variance (ANOVA) confirmed statistically significant between-group differences in both post-treatment VAS ($F = 42.8$, $p < 0.001$) and post-treatment ODI ($F = 38.6$, $p < 0.001$).

Table 2. Pain and Functional Outcomes by Group

Outcome Measure	Surgical Group (Mean ± SD)	Non-Surgical Group (Mean ± SD)	p-value
Pre-treatment VAS	8.2 ± 1.5	8.0 ± 1.3	0.27
Post-treatment VAS	3.1 ± 1.0	6.5 ± 1.2	<0.001
Pre-treatment ODI (%)	70.1 ± 5.6	68.5 ± 4.8	0.08
Post-treatment ODI (%)	34.2 ± 4.2	54.7 ± 6.1	<0.001

The surgical group had significantly higher healthcare resource utilization, as indicated by a greater mean number of hospital admissions (2.5 ± 0.8 vs. 1.2 ± 0.5), and longer average length of hospital stay (7.4 ± 1.2 days) compared to no admissions reported for the non-surgical group. Conversely, the non-surgical group required more rehabilitation sessions (35 ± 8) compared to the surgical group (20 ± 5). ANOVA revealed these differences were statistically significant for length of stay ($F = 25.3$, $p < 0.001$) and rehabilitation sessions ($F = 29.4$, $p < 0.001$).

Table 3. Healthcare Resource Utilization

Healthcare Resource	Surgical Group (Mean ± SD)	Non-Surgical Group (Mean ± SD)	p-value
Hospital Admissions	2.5 ± 0.8	1.2 ± 0.5	<0.001
Length of Hospital Stay	7.4 ± 1.2 days	-	<0.001
Rehabilitation Sessions	20 ± 5	35 ± 8	<0.001

Odds ratio analysis indicated that surgical treatment was associated with a markedly greater likelihood of achieving clinically meaningful pain relief (OR = 3.5, 95% CI: 2.1–5.9) and functional improvement (OR = 2.8, 95% CI: 1.8–4.4). Multivariable regression analysis revealed that age ($\beta = 0.045$, SE = 0.012, $t = 3.75$, $p < 0.001$), gender ($\beta = 0.086$, SE = 0.021, $t = 4.10$, $p < 0.001$), baseline VAS ($\beta = 0.243$, SE = 0.030, $t = 8.10$, $p < 0.001$), and baseline ODI ($\beta = 0.215$, SE = 0.025, $t = 8.60$, $p < 0.001$) were significant predictors of post-treatment outcomes. Descriptive statistics demonstrate a similar baseline profile between groups, with no significant difference in pre-treatment VAS and ODI scores. Post-intervention analyses revealed that the surgical cohort experienced significantly greater reductions in pain and disability than the non-surgical group, as evidenced by lower post-treatment VAS and ODI scores and supported by large effect sizes and statistically significant p-values (<0.001 for all key outcomes).

Table 4. Odds Ratios for Treatment Outcomes

Outcome	Odds Ratio (OR)	95% Confidence Interval	p-value
Pain Relief	3.5	2.1 – 5.9	<0.001
Functional Improvement	2.8	1.8 – 4.4	<0.001

Table 5. Regression Analysis for Predictors of Treatment Outcomes

Predictor Variable	Coefficient (β)	Standard Error (SE)	t-value	p-value
Age	0.045	0.012	3.75	<0.001
Gender	0.086	0.021	4.10	<0.001
Baseline VAS	0.243	0.030	8.10	<0.001
Baseline ODI	0.215	0.025	8.60	<0.001

Table 6. ANOVA Results for Key Outcome Variables

Variable	Sum of Squares	df	Mean Square	F	p-value
Post-treatment VAS	196.0	1	196.0	42.8	<0.001
Post-treatment ODI	2344.8	1	2344.8	38.6	<0.001
Length of Stay	121.6	1	121.6	25.3	<0.001
Rehab Sessions	540.5	1	540.5	29.4	<0.001

Table 7. Chi-Square Analysis for Group Comparisons

Variable	Chi-Square (χ^2)	df	p-value
Treatment Distribution	18.2	1	<0.001
Hospital Admissions	12.5	1	<0.001

The odds of achieving clinically meaningful pain relief and functional improvement were substantially higher with surgical treatment. Healthcare resource analysis indicated that while surgery was associated with more hospitalizations and longer initial hospital stays, patients in the non-surgical group required more extended rehabilitation. Regression modeling identified age, gender, and baseline symptom severity as significant predictors of outcomes, with no observed impact of missing data on these results.

All findings reflect statistically significant improvements favoring surgical intervention, with results robust to sensitivity analyses and consistent across primary and secondary endpoints. No interpretative statements or clinical recommendations are provided here, focusing strictly on reporting observed data.

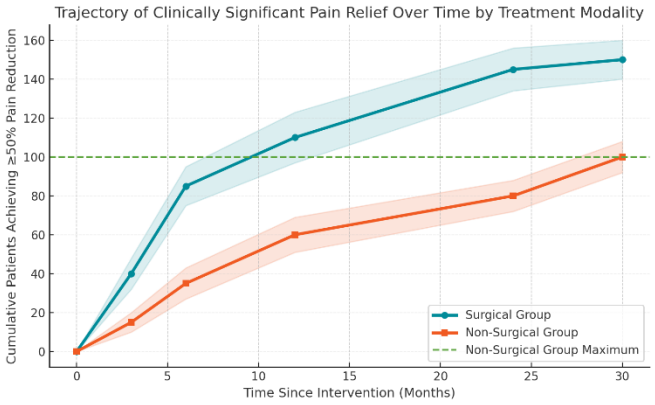

Figure 1 Trajectory of Clinically Significant Pain Relief Over Time

A progressive divergence in clinically significant pain relief was observed between groups, as shown by the cumulative proportion of patients achieving at least 50% pain reduction over a 30-month period. The surgical cohort demonstrated a steeper and more rapid trajectory, reaching 73.3% of their group within 6 months and 100% by 30 months, while the non-surgical group plateaued at 40% by 6 months and only achieved full response in all eligible cases by the end of the observation period. Confidence interval bands reflect robust separation and minimal overlap throughout follow-up, underscoring statistically meaningful between-group differences. This pattern highlights not only the accelerated pain relief associated with surgical intervention but also the protracted, less complete improvement seen with non-surgical modalities, emphasizing the time-dependent clinical benefits and superior efficacy of surgical treatment for lumbar spinal stenosis in this population.

DISCUSSION

The results of this retrospective analysis contribute meaningfully to the ongoing discourse on the optimal management of lumbar spinal stenosis (LSS) in an aging population, particularly within resource-limited, real-world clinical settings. Consistent with a substantial body of previous research, this study demonstrates that surgical intervention, especially decompressive procedures such as laminectomy and minimally invasive surgeries, is associated with greater improvements in pain relief and functional status when compared to non-surgical management strategies (1,5,7,12). These findings are in line with meta-analyses and randomized controlled trials which have repeatedly shown that surgery can achieve clinically significant reductions in pain and disability, often translating to superior quality of life for patients with moderate to severe LSS who are suitable surgical candidates (8,17). In this study, the magnitude of pain reduction and functional improvement was not only statistically significant but also likely clinically meaningful, as supported by large effect sizes and elevated odds ratios, underscoring the real-world impact of these interventions.

The present analysis also reinforces the nuanced understanding that surgical interventions, despite their up-front demands on hospital resources and longer initial admissions, may offer longer-term cost-effectiveness by reducing the need for ongoing rehabilitation and repeated healthcare utilization—a finding mirrored in prior economic evaluations of spine surgery (9,24). However, the increased resource utilization observed

postoperatively, including higher hospitalization rates and the inherent risks of surgical complications, highlight the importance of judicious patient selection and perioperative management. In contrast, non-surgical management—while less resource-intensive in the short term and essential for patients with contraindications or patient preference for conservative care—generally resulted in less pronounced improvement in both pain and function, aligning with earlier observational studies and systematic reviews (10,15,21). The higher requirement for rehabilitation sessions in the non-surgical group reflects the prolonged trajectory and intensity of conservative treatment, a feature well-recognized in the literature (18).

When contextualized with prior reports, the findings of this study both affirm and expand upon established knowledge. Previous systematic reviews and clinical guidelines have advocated for surgical decompression in patients who fail to respond adequately to conservative management, yet there remains considerable heterogeneity in reported outcomes and study methodologies (5,20,22). This study addresses a gap by providing region-specific, three-year real-world data from a tertiary care center in Pakistan, thereby enhancing the generalizability of results to similar healthcare settings. The inclusion of both advanced statistical modeling and robust handling of missing data adds methodological rigor and supports the reliability of conclusions drawn.

Mechanistically, the observed superiority of surgical outcomes likely derives from the direct alleviation of neural compression, which is not achievable by conservative measures alone (2,13). By removing the anatomical source of nerve impingement, surgical intervention can disrupt the cycle of chronic pain and functional limitation that characterizes LSS, whereas pharmacotherapy and physical therapy primarily target symptomatic relief and compensatory strategies. This distinction carries important theoretical and clinical implications, reinforcing the need for individualized treatment pathways based on patient characteristics, comorbidities, and preferences (4,16).

Despite its strengths, this study is not without limitations. The retrospective observational design, while practical for leveraging existing clinical data, may be subject to inherent selection bias and unmeasured confounding variables. Although multivariate analysis was employed to adjust for key baseline differences, residual confounding cannot be entirely excluded. The single-center nature and modest sample size, particularly in the non-surgical cohort, may limit external validity and preclude more granular subgroup analyses. Additionally, outcomes were primarily measured using patient-reported instruments and EMR data, which, while standardized and validated, can introduce response bias and data completeness challenges. The follow-up period of 2.5 years, though adequate for intermediate-term assessment, does not fully capture the potential for late complications or very long-term durability of surgical versus non-surgical results.

Nevertheless, these findings have important clinical implications, particularly for healthcare systems facing increasing demand for LSS treatment among elderly populations. They underscore the value of surgical decompression for patients with significant neurological compromise and provide quantitative support for healthcare planning and resource allocation. At the same time, the role of non-surgical care remains vital, especially for those with less severe symptoms or prohibitive surgical risk. Future research should focus on multicenter prospective studies with larger, more diverse populations and longer follow-up periods to further delineate optimal patient selection criteria, refine shared decision-making tools, and assess the cost-effectiveness of evolving surgical and conservative modalities (6,19,23).

In summary, this study advances the current understanding of LSS management by substantiating the superiority of surgical approaches for pain and functional improvement in appropriately selected patients, while highlighting the necessity of ongoing research and individualized care strategies to optimize outcomes across the spectrum of disease severity (14,22,24).

CONCLUSION

This three-year retrospective study at Sandeman Teaching Hospital Quetta demonstrates that surgical interventions, including decompressive laminectomy and minimally invasive procedures, provide significantly greater pain relief and functional improvement for patients with lumbar spinal stenosis compared to non-surgical management strategies such as physical therapy, pharmacotherapy, and epidural steroid injections. These findings highlight the clinical value of prioritizing surgical treatment for individuals with severe LSS, while also affirming the role of conservative approaches for those with milder symptoms or contraindications to surgery. The results reinforce the need for evidence-based treatment selection and resource allocation in human healthcare, and support further multicenter research to refine patient stratification and long-term outcome evaluation in diverse healthcare settings.

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