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Original Research Article

MINIMALLY INVASIVE OVER THE TOP DECOMPRESSION IN MULTILEVEL LUMBAR STENOSIS: CLINICAL RESULTS

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ABSTRACT

Background: *Multilevel lumbar spinal stenosis (LSS) is a common degenerative spinal condition in the elderly population, often leading to significant disability and reduced quality of life. Traditional open surgeries can be associated with higher morbidity, prompting the shift towards minimally invasive techniques such as "over-the-top" decompression, which preserves spinal stability while achieving effective neural decompression.* ***Objective:*** *To evaluate the clinical outcomes of minimally invasive over-the-top decompression in patients with multilevel lumbar spinal stenosis.* ***Study Design:*** *Cross-sectional study.* ***Setting:*** *Department of Neurosurgery, Lady Reading Hospital, Peshawar, Pakistan.* ***Duration of Study:*** *Three years, from January 2021 to December 2023.* ***Methods:*** *A total of 320 patients aged 50 years or older with MRI-confirmed multilevel lumbar spinal stenosis were included. All patients underwent minimally invasive over-the-top decompression under general anesthesia. The primary outcome was the change in Oswestry Disability Index (ODI) scores. Secondary outcomes included changes in pain scores using the Visual Analog Scale (VAS), walking distance, analgesic consumption, and postoperative complications. Data were analyzed using SPSS version 25.0. Paired t-tests were employed to compare preoperative and postoperative values, with a significance level set at $p < 0.05$.* ***Results:*** *The mean age of the cohort was 65.6 ± 7.8 years, with 53.4% male and 46.6% female patients. ODI scores significantly improved from a preoperative mean of 42.6 ± 10.4 to 22.4 ± 8.6 postoperatively ($p < 0.001$). VAS pain scores decreased from 7.9 ± 1.2 to 3.2 ± 1.4 ($p < 0.001$). Walking distance increased from 100.6 ± 20.4 meters to 300.8 ± 50.6 meters postoperatively. There was also a marked reduction in analgesic usage. The complication rate was low and within acceptable limits.* ***Conclusion:*** *Minimally invasive over-the-top decompression for multilevel lumbar spinal stenosis offers significant clinical improvement in terms of pain relief, functional disability, and walking capacity, with a favorable safety profile and reduced postoperative morbidity.*

Keywords: Minimally Invasive Surgery, Over-The-Top Decompression, Lumbar Spinal Stenosis, Oswestry Disability Index, Visual Analog Scale, Complications, Surgical Outcomes

INTRODUCTION

Lumbar spinal stenosis (LSS) implies to constriction of lumbar vertebrae within the central canal, lateral recess, as well as neural foraminal regions (1). Central canal stenosis has potential to compress thecal sac as well as bilateral spinal sections that, in severe cases, may contribute to manifestation of bilateral symptoms. Lateral recess as well as neural foraminal stenosis can lead to compression of nerve roots, which causes unilateral lumbar radiculopathy indications (2). Central stenosis occurs due to hypertrophy of the anterior ligamentum flavum, and this is further exacerbated by the posterior disk protruding. The prevalence of this medical condition is higher at L4-L5 level compared with different spinal segments. Lateral recess stenosis takes place due to facet arthropathy as well as formation of osteophytes, which restrict the nerve before its transition via intervertebral foramen. Foraminal stenosis results from a decrease in disk height, protrusion of the foraminal disk, as well as the formation of osteophytes. The alterations affect nerve root located within intervertebral foramen. Extraforaminal stenosis usually arises from a distant lateral disk herniation. This condition results in the compression of the nerve root following its exit from the intervertebral foramen along a lateral direction (2, 3).

Developmental lumbar spinal stenosis is recognized as a developmental occurrence, the presence of multilevel stenosis is anticipated, and such individuals are at risk for experiencing neural compression at different stages (4-7). This results in an elevated likelihood of reoperation accomplishing as high as 22%, if levels in DSS are not effectively decompressed during initial surgical procedure (8-10). It is vital to pinpoint any of the stenotic levels before index surgery which might also require prophylactic decompression. This can exclusively be accomplished through utilization of a precise, accurate, as well as standardized diagnostic instrument. Throughout the years, multiple radiological thresholds have been recommended to delineate DSS (5-7,11).

Minimally Invasive decompression (MIL) has acquired substantial popularity in the past few years, attributed to its affordability. Furthermore, research indicates that MIL methods may offer advantages including decreased blood loss, shorter hospital stays, reduced pain levels, as well as enhanced quality of life (12-14). MIL techniques are established procedures utilized to decompress the lumbar spine in instances of LSS. MIL techniques focus on decreasing tissue disruption while retaining the integrity of the majority of the posterior elements, which could improve load-bearing capacities as well as biomechanical stability (12-14).

Minimally invasive over-the-top decompression has emerged as a promising alternative to conventional decompression techniques for treating multilevel lumbar spinal stenosis which aims to minimize tissue disruption while achieving adequate neural decompression. Despite growing interest, there remains limited clinical evidence on the effectiveness as well as safety of minimally invasive over-the-top decompression in multilevel cases. This study aims to evaluate functional improvements following this technique thereby contributing valuable data to guide surgical decision-making and optimize patient care in lumbar spinal stenosis.

METHODOLOGY

The cross-sectional study was conducted at Lady Reading Hospital in Peshawar from January 2021 to December 2023. The research protocol (IRB number: LRH/2021/478) was approved by the Institutional Review Board (IRB) of Lady Reading Hospital.

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We enrolled patients who were aged 50 years or older and had multilevel lumbar spinal stenosis, which was confirmed by MRI. We excluded patients with congenital spinal defects, previous lumbar spine surgery, severe comorbid conditions contraindicating surgery, and lack of informed consent. Surgeries were conducted under general anesthesia, over-the-top decompression was the surgical procedure performed by an experienced surgeon having experience of more than 5 years, to decompress the spinal canal by excising part of the lamina, preserving spinal stability.

The primary outcome of our study was the change in Oswestry Disability Index (ODI) scores from preoperative to postoperative follow-up. Secondary outcomes were pain reduction measured by the Visual Analog Scale (VAS), increase in walking distance, reduction in analgesic use and postoperative complications.

Data were recorded using pre-designed pro-froma which included demographics and clinical parameters such as age, gender, BMI, and comorbidities such as coronary artery disease, hypertension, and diabetes. ODI and VAS scores were measured preoperatively and at 3 months postoperatively. Walking distance and analgesic usage were also assessed. Postoperative complications include wound infection, dural tear and reoperation.

The gathered data was then analyzed with SPSS version 26.0. Continuous variables were evaluated using mean ± standard deviation. Categorical variables were evaluated using frequencies and percentages. For comparing pre and postoperative continuous variables, we used T-test, keeping the value of P significant at ≤ 0.05.

RESULTS

A total of 320 patients were enrolled. The average age was 65.6± 7.8 years. The mean BMI was 27.4±4.6 kg/m^2. There were 171 men (53.4%) and 149 women (46.6%) (Figure 1). The comorbidities included hypertension in 38.4%, diabetes mellitus in 29.6%, and coronary artery disease in 15.4% of the patients (Table 1). The primary outcome showed significant improvement in disability levels. The mean preoperative ODI score was 42.6 (SD ±10.4), which dropped to 22.4 (SD ± 8.6) at the 3-month follow-up ($p < 0.001$) (Table 2).

Pain scores on the VAS scale improved significantly from a preoperative mean of 7.9±1.2 to a postoperative mean of 3.2 ±1.4 ($p < 0.001$). Walking distance increased from 100.6± 20.4 meters to 300.8± 50.6 meters. Analgesic use declined from 2.6±0.7 doses/day to 0.9± 0.4 doses/day (Table 3).

The overall complication rate was 14.7% which included wound infections in 5.4%, dural tears in 4.0%, and reoperation in 2.9% of patients (Table 4).

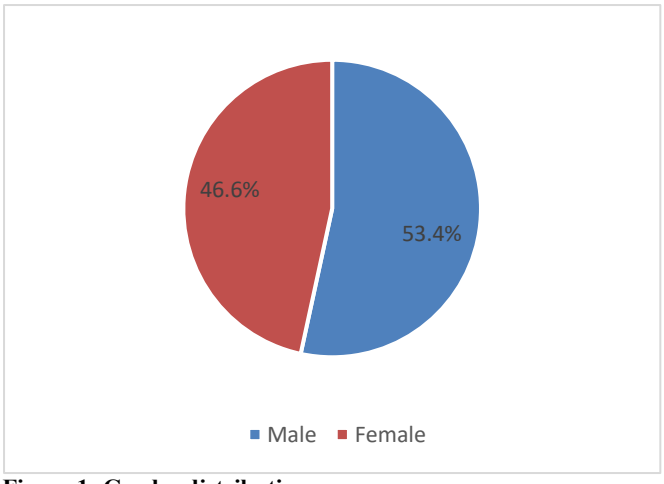

Figure 1: Gender distribution

Table 1: Comorbidities

Comorbidities	Frequency	Percentage
Hypertension	123	38.4
Diabetes Mellitus	95	29.6
Coronary Artery Disease	49	15.4

Table 2: Change in ODI scores pre- and post-surgery

ODI	Mean	P value
Preoperative ODI	42.6±10.4	P < 0.0001
Postoperative ODI	22.4± 8.6	

Table 3: Secondary Outcomes

Secondary outcomes	Preoperative Mean	Postoperative Mean	P value
VAS Score	7.9±1.2	3.2±1.4	<0.001
Walking Distance (m)	100.6±20.4	300.8±50.6	<0.001
Analgesic Use (daily)	2.6±0.7	0.9±0.4	<0.001

Table 4: Postoperative Complications

Complications	Frequency (%)	Percentage
Wound Infection	17	5.4%
Dural Tear	13	4%
Reoperation	9	2.9%
Overall	47	14.7%

DISCUSSION

The OTT involves a unilateral laminotomy to achieve bilateral decompression and offers several advantages over traditional open decompression surgeries. The procedure as shown in our study is minimally invasive and focuses on reducing the need for extensive muscle dissection and bone removal, thereby preserving spinal stability while effectively decompressing the neural elements.

In our study 320 patients were enrolled which included 53.4% men and 46.6% women with a mean age of 65.6 years. The mean body mass index (BMI) was 27.4 kg/m², and common comorbidities included hypertension (38.4%), diabetes mellitus (29.6%) and coronary artery disease (15.4%). The baseline Oswestry Disability Index (ODI) score was 42.6±10.4, indicating moderate to severe disability, which significantly improved postoperatively to 22.4±8.6. Pain scores measured using the Visual Analog Scale (VAS) had also demonstrated substantial improvement from a mean of 7.9±1.2 preoperatively to 3.2±1.4 postoperatively. The results of walking distance and analgesic use were equally encouraging, with patients showing a marked increase in walking distance and a substantial reduction in the use of analgesics. The overall complication rate was 14.7% with the most common complications being wound infections (5.4%) followed by dural tears (4.0%) and the need for reoperation (2.9%).

The results of our study align with Khan et al, the authors evaluated the outcomes of over-top decompression but focused on single-level lumbar stenosis. The patients in their study had a mean age of 46 years and similar to our study the majority in their study were male. Their findings showed that 83.1% of patients had improved leg pain post-surgery. While their study did not report a direct measure of disability using the ODI, the overall patient satisfaction rate was 82.5%, which mirrors the positive outcomes found in our study (15). However a key difference between the two studies is the complication rate which was 10.38% in Khan et al.'s study lower than the 14.7% complication rate in our study, this difference could be attributed to the inclusion criteria, as in our study we enrolled patients with multilevel lumbar spinal stenosis, while their study had patients with single level lumbar

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stenosis.

Ulrich et al in their trial compared the unilateral laminotomy with bilateral decompression (ULBD) approach with the standard open bilateral decompression (SOBD). Their multicenter cohort study, although they focused on a longer follow-up period (3 years), demonstrated that the ULBD approach provided comparable outcomes to SOBD in terms of symptom relief and functional improvement. However, they found that ULBD was technically more challenging with no notable difference in the long-term functional outcomes between the two approaches (16). Further supporting our findings, a study by Kulkarni et al demonstrated that single-incision tubular decompression for multilevel lumbar stenosis was feasible and led to excellent clinical outcomes. The study found significant improvement in both VAS scores for back and leg pain and the ODI improved from 44.6 preoperatively to 20.2 at 3 months, which was similar to the improvements observed in our study (17). The 6.95% rate of dural tears in our study was lower than the 16.3% rate reported by Fontes et al The higher rate in their study could be attributed to their smaller sample which was 102 patients compared to 320 in our study (18).

CONCLUSION

In conclusion, minimally invasive over-the-top decompression for multilevel lumbar stenosis exhibited substantial clinical improvements in pain, disability, and mobility with a lower complication rate. Considering its effectiveness in preserving spinal stability and reducing recovery time, we recommend that this technique be considered a viable option in clinical practice. Future studies with larger cohorts, a comparison arm and extended follow-up should be conducted to further validate these findings.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRBEC-LRH/2021/478)

Consent for publication

Approved

Funding

Not applicable

CONFLICT OF INTEREST

The authors declared an absence of conflict of interest.

AUTHOR CONTRIBUTION

ZIA UR REHMAN (Assistant Professor)

Conception of Study, Conception of Study, Final approval of manuscript, Manuscript drafting.

BASHIR ULLAH (Postgraduate Resident)

Development of Research Methodology Design, Study Design, Review of manuscript.

SYED SHAYAN SHAH (Postgraduate Resident)

Data entry data analysis

MUHAMMAD SOHAIB (Postgraduate Resident)

Manuscript revisions, critical input.

MUHAMMAD AAMIR (Postgraduate Resident)

Review of Literature, Review of manuscript

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