SHORT COMMUNICATION

Slalom technique for multilevel degenerative spinal stenosis, surgical outcome and complication rate: Review of our experience

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Abstract

Lumbar canal stenosis (LCS) is a common spinal disease affecting the elderly. Primarily it is asymptomatic until there is neurogenic claudication. Minimally invasive surgical (MIS) techniques are used to treat patients with lumbar spinal stenosis (LSS), while tubular system with alternative multilevel decompression is specifically used for those with minimal back pain and no mechanical instability on dynamic imaging. The aim of the study is to evaluate surgical outcome of Slalom procedure and complications in Middle East population. One hundred and five patients with lumbar stenosis (61 males and 44 females) underwent the procedure between 2015-2021 who were regularly followed-up using preoperative and postoperative COMI score (the core outcome measure index) at six months after index surgery. Progressive improvement in COMI score from average seven pre-op score to an average of three after six months of index surgery. The postoperative complications were dural tear (6.67%), Postoperative infection (3.81%), mechanical instability (1.9%), postoperative neuritis (8.57%) and death (1.9%).

Keywords: Disc degeneration, Laminectomy, Decompression.

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Introduction

Lumbar Spinal Stenosis (LSS) is a prevalent spinal condition that affects the elderly population, and is characterised by degenerative processes like ligamentum flavum hypertrophy, calcification, facet joint arthroplasty, disc degeneration, prolapse, and osteophytes.[1] These processes compress the dural sac and nerve roots, leading to symptoms such as neurogenic claudication, back pain, buttock or lower extremity pain, significantly impacting mobility and daily activities. Consequently, LSS remains the most common reason for spinal surgical interventions.[2]

When conservative treatments fail to alleviate symptoms, surgical options become essential for managing LSS. However, choosing the best surgical technique remains a subject of debate. Over the past decade, there has been a notable increase in lumbar spine decompression surgeries for LSS.[3] The primary goal of these procedures is to decompress the affected neural structures while ensuring mechanical stability.[4] The conventional "Total laminectomy" has been considered the gold standard for severe symptomatic LSS.[5] Nonetheless, this procedure is associated with several drawbacks, including extensive tissue trauma, infection risks, increased blood loss during surgery, postoperative instability, and high rates of re-operation and secondary fusion.[6] Recognising the limitations of traditional total laminectomy, medical advancements have led to the development of minimally invasive surgical (MIS) approaches for LSS.

Among these, the bilateral microsurgical "cross-over decompression" through a unilateral approach (Slalom technique), popularised by Mayer et al,[7] has gained prominence which is selective, bilateral multi-segmental microsurgical decompression of lumbar spinal canal stenosis through separate, alternating cross-over approaches. This innovative technique aims to reduce tissue trauma often associated with conventional open decompression across multiple segments. Additionally, it retains the advantages of unilateral over-the-top decompression while fully preserving the contralateral inferior facet and its surrounding capsular structures.

The present study aims to evaluate the surgical outcomes and early complication rates of the slalom technique. This approach, involving bilateral microsurgical "cross-over decompression" through a unilateral approach, has emerged as a promising minimally invasive surgical treatment for degenerative LSS. By examining the results and complication rates of this technique, we hope to contribute valuable insights into its effectiveness and safety as a surgical intervention for Lumbar Spinal Stenosis.

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Patients / Methods and Results

A total of 105 patients diagnosed with multiple degenerative spinal stenosis were treated between January 2015 and August 2020 at two spine centres (Royal private hospital and Al-Mustansiria medical college, Baghdad, Iraq) by three skilled surgeons. The surgical approach employed Multiple Unilateral Laminotomy with Bilateral Decompression (ULBD) of multilevel using the slalom technique. The inclusion criteria encompassed patients with a history of neurogenic claudication resulting from degenerative spinal stenosis. These individuals had not experienced relief from conservative treatments for at least three months. The stenosis types considered were central, posterolateral, and lateral recess stenosis, and at least two levels were involved. Only patients who had not had prior surgeries at the same level and did not have mechanical or structural spinal deformities were included in the study. Patients with spinal stenosis other than degenerative cases, spondylolisthesis, individuals deemed medically unfit for the procedure, and those with scoliosis were excluded from the study. Before the surgery, written consent was obtained from all patients and their relatives. A comprehensive preoperative clinical and radiological assessment was conducted for all patients. The clinical criteria included neurogenic claudication with or without backache, with a walking distance of less than 300 metres, and associated paraesthesia that had not responded to conservative treatment for at least three months. Vascular claudication and other potential causes of disabilities were ruled out. The assessment of symptoms and functions was performed using the COMI score.[8] Prior to the surgery, all patients underwent standard anteroposterior (AP), lateral, and dynamic views of the lumbar spine (LSS) as well as MRI scans.

During the surgery, the patient was placed under general anaesthesia and intubated with an endotracheal tube. As part of the anaesthesia induction, a preoperative antibiotic, 1 gm Cefazoline IV, was administered. The patient was positioned prone on a Jackson frame to facilitate abdominal exposure, and bony prominences were padded for added comfort.

Using fluoroscopy, the specific spine level was identified. A 2cm incision was made at the most symptomatic site of that level and the adjacent level, choosing the contralateral side. The 22mm Medix Tubular system and Microscope were employed to perform decompression. Laminotomy and flavectomy were carried out on the ipsilateral side using a high-speed drill and Kerrisons. The operating room table was tilted contralaterally, and the tube was bent to adjust the microscope obliquely for a clear view of the contralateral side. Decompression of the contralateral side was performed in a similar manner. After ensuring haemostasis, the area was irrigated and sutured in layers. A Redivac drain was left in place to aid in postoperative drainage.

After the surgery, it is recommended that the patient is provided postoperative analgesia and early movement of their legs is encouraged. Patients were encouraged to start walking on the next day after the operation and were kept in the hospital for 1-2 days before discharge. Two weeks later, the stitches were removed, and the clinical surgical outcome was assessed using the COMI score at preoperative, postoperative two-week, six-week, twelve-week, and six-month follow-up visits.

To evaluate the effectiveness of the treatment, the preoperative and postoperative COMI scores at different time points were compared. Categorical variables were analysed using the Fisher test, while continuous variables were assessed using the t-test. Pearson correlation analysis was used to determine the correlation between two continuous variables (postoperative COMI score at six months and preoperative COMI score), and Spearman q correlation analysis was performed for one continuous and one categorical variable. A *p*-value of 0.05 was considered statistically significant.

Statistical analysis was conducted using the GraphPad QuickCalcs online statistical analysis tool developed by GraphPad Software in San Diego, California.

Over the period of January 2015 to August 2020, a total of 105 patients suffering from multiple spinal stenosis involving the lower dorsal and lumbar spine underwent surgery using the slalom technique by three expert spine surgeons. The patients' demographic distribution is outlined in Table. The mean age at presentation was 60.76±1.2 years, with 49.52% of patients falling within the age range of 60-70 years. Among the cases, 61 (58%) were males, while 44 (42%) were females.

The distribution of patients according to the number of affected levels was as follows: 28 (26.67%) patients had two affected levels, 64 (60.95%) patients had three affected levels, and 13 (12.38%) patients had four affected levels. In total, there were 300 operated levels, with the most frequently operated level being L4-5 in 93 (31%) patients, followed by L5-S1 in 69 (23%) patients, L3-L4 in 68 (22.7%) patients, L2-L3 in 48 (16%) patients, L1-L2 in 13 (4.33%) patients, D12-L1 in 7 (2.33%) patients, and D11-D12 in 2 (0.67%) patients.

Regarding comorbidities, 18 (17.14%) patients were smokers, 29 (27.62%) had hypertension, 17 (16.19%) had diabetes, 1 (0.95%) had renal insufficiency, and 31 (29.52%) were obese.

The average operative time per level was approximately 46 ±18minutes, and the mean blood loss per patient was 57±19 cc.

Table: Patient demographics, affected spinal level and complications.

	n (%)	
Age (years)		
30-40	3 (2.86)	
41-50	9 (8.57)	
51-60	25 (23.81)	
61-70	52 (49.52)	
71-80	13 (12.38)	
>80	3 (2.86)	
Total	105	
Gender		
Male	44 (42)	
Female	61 (58)	
Total	105	
Spine Levels		
D11-12	2 (0.67)	
D12-L1	7 (2.33)	
L1-L2	13 (4.33)	
L2-L3	48 (16.00)	
L3-L4	68 (22.67)	
L4-L5	93 (31.00)	
L5-S1	69 (23.00)	
Total	300	
Co-Morbidities		
Smoking	18 (17.14)	
Hypertension	29 (27.62)	
Diabetes	17 (16.19)	
Renal Impairment	1 (0.95)	
Obesity	31 (29.52)	
Total	96	
Level		**Total Level**
2 Levels	28 (26.67)	56
3 Levels	64 (60.95)	192
4 Levels	13 (12.38)	52
Total	105	300

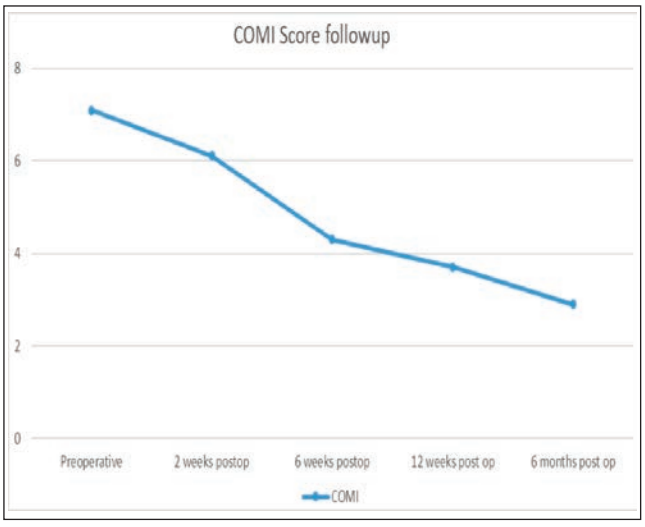

Figure-1: COMI Score.

Postoperative complications were observed in some cases: dural tear occurred in 7 (6.67%) patients, postoperative infection in 4 (3.81%) patients, mechanical instability in 2 (1.9%) patients, postoperative neuritis in 9 (8.57%) patients, and there were 2 (1.9%) cases of mortality.

Postoperative follow-up was scheduled at regular intervals of two weeks, six weeks, three months, and six months. Clinical assessments were conducted, and surgical outcomes were evaluated using the COMI (Core Outcome Measures Index) score. These results were then compared with preoperative measures and are shown in Figure 1. Pre-op and post-op MRI of one of the patients is attached. (Figure 2 and Figure 3)

Out of the total number of patients, 99 successfully

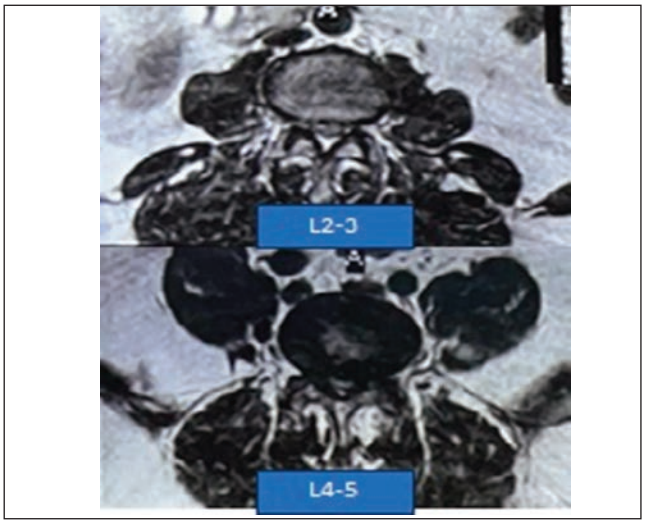

Figure-2: Pre-op MRI of patient.

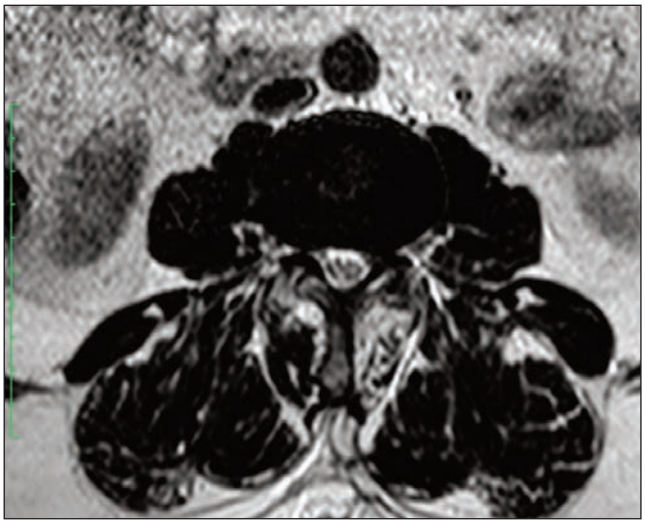

Figure-3: Post op MRI.

completed the six-month postoperative follow-up. However, six cases did not complete the follow-up, two of whom expired due to myocardial infarction and pulmonary embolism respectively. The remaining four patients were lost to follow-up, as they did not come in for their scheduled appointments at three months and six months.

Discussion

The study results demonstrate that surgical treatment of lumbar spinal stenosis yields better outcomes compared to non-surgical approaches, as indicated by previous research.[9,10] Minimally Invasive Surgery (MIS) techniques have been developed to improve surgical outcomes, facilitate early mobilisation, and reduce complications, with numerous articles highlighting their superiority in treating various spinal pathologies.[6,11]

The study population consisted predominantly of male patients (58%), likely influenced by their dominant role in providing financial support and higher smoking rates in our society. The most commonly operated levels were L4-5 (31%) and L5-S1 (23%), given their increased mobility and susceptibility to degenerative changes and symptomatic pathologies.

The majority of patients (62%) underwent surgery involving three affected levels. The treatment's success was assessed using the COMI score, showing a significant improvement from a preoperative mean of 7.1 to 2.9 at the six-month follow-up.

Out of the total 105 patients, 19 (18%) experienced complications. Among these, seven patients (6.6%) had dural tears, with conservative management for small tears and open conversion with suturing for larger tears. Postoperative infections were observed in four (3.81%) patients, with local debridement and antibiotics used for treatment. Nine (8.5%) patients developed postoperative neuritis, which presented as radiculopathy without neurological deficit and was managed with reassurance and medication.

Mechanical instabilities were seen in two cases due to facet removal during decompression, leading to backache but requiring no further interventions. One patient developed right-sided foot drop postoperatively, and although MRI revealed no abnormalities, partial improvement was observed on six-month follow-up.

Two patients died during the follow-up period due to myocardial infarction and pulmonary embolism respectively, both of whom had comorbidities (IHD). The study's limitations include the absence of a control group and the involvement of three surgeons, potentially influencing postoperative complications and the learning curve.

Despite these limitations, the study provides valuable insights into the effectiveness and challenges of MIS for lumbar spinal stenosis, highlighting its advantages over non-surgical treatments and traditional open techniques. Further research with larger cohorts and control groups would be beneficial to validate these findings and address the identified limitations.

Conclusion

The present study demonstrates that Multiple Unilateral Laminotomy and Bilateral Decompression (ULBD) using the Slalom Technique is a safe and highly effective approach for managing patients with multiple lumbar stenosis. Careful preoperative evaluation to identify eligible candidates for this technique is crucial, as it allows surgeons to avoid unnecessary instrumentation, extensive soft tissue injuries, and potential instabilities associated with traditional open techniques.

The results indicate that this minimally invasive procedure offers favourable outcomes, with significant improvements in patients' symptoms and functional status, as measured by the COMI score. Moreover, the low prevalence of complications and the successful resolution of postoperative complications further validate the feasibility and safety of the ULBD Slalom Technique.

Limitations: A control group was lacking and the surgery involved multiple surgeons, which may have impacted the outcomes and complications.

Conclusion, Multiple Unilateral Laminotomy and Bilateral Decompression (ULBD) using the Slalom Technique is a valuable addition to the surgical armamentarium for treating multiple lumbar stenosis cases. Its ability to achieve positive outcomes while minimising complications makes it an appealing option for eligible patients.

Recommendation: Continued research and refined techniques are warranted to further optimise patient selection and ensure the best possible outcomes in the treatment of lumbar spinal stenosis.

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Conflict of Interest: None.

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Author Contribution:
GAH: Study design, concept.
HQR: Questionnaire design.
SK: Literature search, writing.
YBW: Data analysis.
AA: Data interpretation.
MK: Data collection