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Outcome of Microscopic Unilateral Laminotomy for Bilateral Decompression of Acquired Lumbar Spinal Stenosis

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ABSTRACT

Background: Degenerative lumbar spinal stenosis (LSS) remains one of the most common indications for lumbar spine surgery in elderly patients. **Aim of the study:** to assess the results of a minimally invasive bilateral decompression surgery with a unilateral laminectomy (ULBD).

Patients and methods: an upcoming clinical trial investigation was conducted at the Neurosurgery Department of Zagazig University hospital during the period from November 2021 to August 2022. 24 patients were included in our study. Demographic, Clinical outcomes were assessed, both before and after surgery, The Visual Analogue Scale was used to rate leg and low back discomfort (VAS). Before and after surgery, disability was assessed using the Oswestry Disability Index (ODI) 3 months postoperatively. Pre- and postoperative measurements of the size of the spinal canal and the approximate cross-sectional area (CSA) of the dural sac were made.

Results: VAS for low back pain (LBP) improved from 6.83 ± 2.65 to 1.79 ± 0.70, while VAS for leg pain improved from 6.54 ± 3.04 to 1.87 ± 0.59. ODI significantly decreased from 57 ± 6.75 % to 18.58 ± 5.01 %. A-P diameter increased from 9.12 ± 0.46 to 13.60 ± 0.61 mm, while. ADSCSA of the stenotic levels increased from 90.67 ± 4.32 to 167.37 ± 26.74 mm^2.

Conclusion: ULBD techniques is effective and safe procedure for LSS treatment, with good postoperative outcome.

Keywords: Laminectomy, Laminotomy, Lumbar spinal stenosis.

INTRODUCTION

Spinal stenosis in the lower back (LSS) refers to the lumbar spinal canal's anatomical constriction and is linked to a variety of clinical problems. According to reports, there are five incidences of LSS per 100,000 people per year. Neurogenic claudication, which is caused by localized bony and/or discoligamentous constriction of the spinal canal, is the defining sign of LSS [(1)].

One cause of LSS is disc degeneration, which causes the canal to shrink ventrally and, as a result, the neural foramen and lateral recess to narrow as well. The facet joints are put under more load as a result of increased segmental motion caused by ligamentous laxity, which is biomechanically affected. This subclinical instability causes osseous hypertrophy in the bone structures, which manifests as facet joint hypertrophy. The ligamentum flavum folds inwards due to height reduction and exhibits fibrotic hypertrophy. Last but not least, disc degradation and the apparent instability of spondylolisthesis may be brought on by laxity of ligaments and capsules even while these reactive processes fail to stabilize the segment [(1, 2)]

The location of the spine has an impact on the nerve root compression caused by these pathoanatomical modifications. The neural foramina, central canal, or lateral recess are three separate anatomic sites where narrowing can be precisely defined [(3- 7)].

The advancement of magnetic resonance imaging and the growing understanding of pathoanatomy have combined to allow for a more precise distinction between the diseases of bone and soft tissue stenosis including their types and the degree of the stenosis[(6)]. When medically conservative treatment for LSS decompression fails, whether there is or is not a neurological deficiency, surgery is recommended (motor or sphincteric).

In order to without first releasing the imprisoned neuronal components compromising the integrity of the afflicted segment, surgery is used to treat bilateral sciatica in LSS [(5)].

The procedure known as laminectomy is frequently done to treat lumbar spinal stenosis. The main issues with this operation are the deterioration of the ligaments and bones in the spine, along with instability and peridural scar development. Numerous techniques, including unilateral laminotomies, bilateral laminotomies, and open-door laminoplasty, have been proposed to address these serious drawbacks. However, because of the complexity of these treatments and a lack of follow-up information regarding postoperative stability, they have never really taken off [(4, 8)]. This study's goal was to evaluate the efficiency of unilateral minimally invasive surgery laminectomy for bilateral decompression (ULBD).

PATIENTS AND METHODS

The research was done at Zagazig's Neurosurgery Department. University hospital during the month of November until 2021 to August 2022. This prospective clinical trial study was conducted on 24 patients to treat acquired lumbar spinal stenosis bilaterally. The research was undertaken after gaining the ethical approval of Zagazig University/College of Medicine. Written informed consent of all the participants was obtained. The study protocol conformed to the Helsinki Declaration, the

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ethical norm of the World Medical Association for human testing.

Inclusion criteria: Age ≥ 18 years. Both sexes were included. Symptomatic patients with acquired lumbar canal stenosis with failed conservative management. General fitness for surgery was considered. Conscious Cooperative patients with consent.

Exclusion criteria: Nondegenerative etiology of lumbar canal stenosis (Congenital Trauma, infections, or tumors). Presence of segmental instability demanding fixation. Uncooperative patients. Severe systemic illness and unfitness for surgery that may obscure the outcome of surgery. Patients who have undergone similar surgery before.

All patients underwent a thorough history taking and clinical examination. Neurological examination, Oswestry Disability Index and the Visual Analogue Scale.

Pain intensity can be measured using a visual analogue scale (VAS). It is a continuous scale made up of a horizontal scale known as the "horizontal visual analogue scale" or a vertical scale known as the "vertical visual analogue scale," which typically has a length of 10 cm or 100 mm [both the gradations are used]. Each severe symptom is described using two-word adjectives., serve as its foundation **[9].** The scale is most typically anchored for pain severity by "no pain" (score of 0) and "pain as bad as it could be" or "worst imaginable pain" (score of 100 [on 100-mm scale]. Usually, Respondents are asked to report their current pain level or their pain level during the last 24 hours [9].

Laboratory investigations were done on all patients (e.g., CBC, PT, PTT, INR, Blood sugar, KFT, LFT and viral markers). Imaging X-ray (AP, Lateral, and Dynamic views) to assess bony elements and stability, MRI to evaluate the site (central canal, lateral recess, or foraminal stenosis), cause and degree of neural compression. All patients received IV antibiotics at induction of anesthesia.

Postoperative regime:

Appropriate antibiotics and analgesics were used. Patients were checked on the 1st postoperative day for possibility of discharge if generally doing well, and wounds were checked for evidence of CSF leak.

Follow up:

Follow up visits after surgery were at 2 weeks for stitches removal and surgical wound evaluation regarding wound infection, at 1 month and 3 months after surgery for radiological and functional evaluation including pain and disability.

Ethical approval:

The study was undertaken after gaining the ethical approval of Zagazig University/College of Medicine.

Statistical Analysis: With the help of SPSS (statistical software for the social science, Chicago, Illinois, USA) version 23, all data were gathered, tabulated, and statistically evaluated.

RESULTS

Table 1; showed that the twenty four patients were treated at Zagazig University Hospital. There were **10** male patients (**41%)** and **14** female patients **(59%)** whose mean age was **(55.7 ± SD 9.61)** (range 21–69 years).

Table (1): Demographic Characteristics.

No. of cases:	**24 Cases**		
Age: (in years)	**Mean Age**	**Standard Deviation**	**Range**
	59	± 9.66	(21– 69)
Sex:	**Males**	**Females**	**Percentage**
	10/24	14/24	Males: 41 % Females:59 %

Duration of symptoms ranged from 3 to 48 months. Preoperative clinical symptoms and signs were **LBP** (87.5%), **leg pain** (83.3%), **neurogenic claudication** (100%), **motor deficit** (12.5%), **sensory affection** (62.5%), **urinary incontinence** (4.1%) **(Table 2).**

Table (2): Preoperative clinical symptoms & signs.

Preoperative symptoms & signs:	**No. of cases:**	**Percentage:**
LBP	21	87.5 %
Leg pain	20	83.3 %
Neurogenic claudication	24	100 %
Motor deficit	3	12.5 %
Sensory affection	15	62.5 %
Urinary incontinence	1	4.1 %

All patients were approached by **microsurgical unilateral laminotomy (fenestration) with bilateral decompression of affected lumbar segments**, and were followed up for 3 months. The postoperative mean **VAS for leg pain** decreased from **6.54 ± 3.04** to **1.87 ± 0.59 (P < 0.0001)** at final follow up. **(Table 3).** There was also significant improvement in **VAS for LBP**, where it decreased from **6.83 ± 2.65** to **1.79 ± 0.7 (P < 0.0001)** at the final postoperative follow up**.** The postoperative mean **ODI** significantly improved from **57% ± 6.75** to **18.58% ± 5.1 (P < 0.0001)**. **(Table 3)**

Table (3): Mean difference between preoperative & postoperative VAS and ODI:

Variables	Preoperative	Postoperative	P – Value	significance
Mean VAS for leg pain:	6.54 ± 3.04	1.87 ± **0.59**	(P < 0.0001)	Significant
Mean VAS of LBP:	6.83 ± 2.65	1.79 ± 0.70	(P < 0.0001)	Significant
Mean ODI:	57 ± 6.75	18.58 ± 5.01	(P < 0.0001)	Significant

The stenotic segments that were operated upon were: **L4-L5** in 12 patients (50%), **L5-S1** in 6 patients (25%), and **L3-L4** in 2 patients (8%). We operated the patients from the most severely affected side and selected a left approach when there was no difference between the two sides.

Regarding the **duration of surgery**, the mean operative time was **134 ± 18 minutes** (range from 110 to 170 minutes). Estimated mean **intraoperative blood loss** was **76.35 ± 20.5 mL.** Postoperative radiological investigations in the form of dynamic lumbosacral x ray showed no evidence of postoperative iatrogenic instability. MR imaging studies demonstrated an increase in lumbar spinal canal size compared with preoperative size. Mean **Approximate dural sac cross-sectional area (ADSCSA)** increased from **90.67 ± 4.32 mm^2** preoperatively to **167.37±26.74 mm^2** postoperatively **(P < 0.0001).** The mean **Antero-Posterior diameter** of the stenotic lumbar segments increased from **9.12± 0.46** to **13.60 ± 0.61 mm (P < 0.0001) (Table 4).**

Table (4): Mean difference between preoperative & postoperative CSA, A-P diameter

Variable	Preoperative	Postoperative	P-Value	Significance
ADSCSA	90.67 ± 4.32	167.37 ± 26.74	(P< 0.0001)	Significant
A–P Diameter	9.12 ± 0.46	13.60 ± 0.61	(P < 0.0001)	Significant

DISCUSSION

This study was prospectively conducted on **24** people with segmental lumbar spinal stenosis that is degenerative subjected to microscopic bilateral decompression using a unilateral strategy of the stenosed lumbar segment(s), with a mean age of **(59 ± SD 9.66 years**) (range 21–69 years). **Male to female** ratio was **1:1.4 (10 males 41% & 14 females 59%).** In the study done by **Çavuşoĝlu *et al.*** [(10)], The study included 100 participants, their age at the time of the operation, was 69.21 ± SD 12.18 years (range 55–83 years). Male to female ratio was 39:61 (39 males 39% & 61 females 61%). Male to female ratio is less than that in our study, but both results are showing good matching with no selection of cases. The mean age was not much different in most studies as degenerative lumbar canal stenosis usually occurs in the older population rather than young/ middle-aged groups.

Preoperative clinical symptoms and signs in our study were **LBP** (87.5%), **leg pain** (83.3%), **neurogenic claudication** (100%), **motor deficit** (12.5%), **sensory affection** (62.5%), **urinary incontinence** (4.1%). **Çavuşoĝlu *et al.*** [(10)] mentioned that 94% of patients complained of LBP, 88% complained of leg pain, 99% complained of claudication, 77% complained of tingling/numbness, 20% had weakness & 2% had incontinence. The stenotic segments that were operated upon were: **L4-L5** in **14** patients **(58 %)**, **L5-S1** in **7** patients **(30 %)**, and **L3-L4** in **3** patients **(10 %).**

On analysis of the **stenotic levels**, we found slight predominance L4-5 level as 50% of stenotic segments occurred at that level, with an incidence of 25% at L5-S1 level and 8% L3-4 level. **Sasai *et al.*** [(11] found L4-5 to be the site of stenosis in most of their cases (24 cases out of 25 cases with degenerative LCS included in their study representing about (96%), followed by L3-4 level (36%), then L5-S1 level (20%) and finally L2-3 level (8%). In this study, we have excluded any patient with spinal instability.

The average estimated **blood loss** in our study was **76.35 ± 20.5mL.**

The average **operative time** was recorded at **134 ± 18 minutes** (range from 110 to 170 minutes). These values proved to be consistent with most papers. According to **Komp *et al.*** [(12)] the average estimated blood loss was 73 mL (20 – 390) and according to **Sasai *et al.*** [(11)] the typical length of an operation was 191 minutes (120–310 min.).

Radiographic measurements of the lumbar canal at the stenotic segments were compared in our study: preoperative versus postoperative after 3 months follow-up.

By measuring the **ADSCSA** of the stenotic segments in our cases, we found that it significantly increased in the postoperative images. **Mean ADSCSA** increased from **90.67±4.32** to **167.37±26.76mm^2**. **Young *et al.*** [(10)] found that the mean ADSCSA in their study increased from **80.04 ± 35.36** to **151.67 ± 53.59**. **Hong *et al.*** [(13)] reported that the ADSCSA increased from

58.4±22.9mm^2 preoperatively to 178.9±43.1 mm^2 postoperatively.

In our study, the final functional outcome at the time of the latest follow-up using the **Visual Analogue Scale (VAS)** for leg pain improved from **6.54 ± 3.04 to1.87 ± 0.59. VAS for LBP** also improved significantly from **6.83 ± 2.65** to **1.79 ± 0.70** at the final postoperative follow up. **ODI** improved from **57% ± 6.75** preoperatively to become **18.58% ± 5.01** postoperatively. **Heo *et al.*** [(14)] had results showing improvement in VAS for Leg pain from 7.67 ± 1.08 preoperatively to 1.94 ± 0.79 at the final follow up, while VAS for LBP decreased from 6.64±1.45 at the preoperative assessment to become 2.03 ± 0.92 at the last checkup, the ODI substantially dropped from 56.36 ± 5.91 preoperatively to 22.58 ± 4.57 postoperatively. **Hong *et al.*** [(13)] found that VAS leg discomfort has decreased since 8.4 ± 2.2 preoperatively to 3.7 ± 3.8 postoperatively, VAS for LBP has improved from 5.9 ± 3.3 to 3.6 ± 2.9 while ODI has decreased from 23.2 ± 9.7 to become 11 ± 10.3 at the final follow up. **Ko *et al.*** [(15)] mentioned that postoperative ODI was 15.92 ± 9.668 after 6 months follow up period.

When documenting incidence of intra and post-operative complications, we had one case of simple unintended durotomy at the side of fenestration, repaired by 0/4 vicryl suture and muscle patch, and one case of nerve root injury turned to open traditional laminectomy for reposition of nerve rootlet and thecal sac repair.

An incidence of is linked to the unilateral method using a microscope and tubular retractor system17.6% (three of 17 patients) [(16)]. The findings of our investigation do not match those found in the literature. None of the individuals in our study experienced an inadvertent durotomy of any surgically treated levels.

After a three-month No one of our patients had spinal hypermobility upon follow-up. In most cases, a unilateral technique enables proper spinal column health and neural tissue decompression stability **Hong *et al.*** [(13)] reported that, in comparison to a typical method, unilateral bilateral decompression lowered the probability of late instability laminectomy. In their study only 1 patient out of 24 patients underwent unilateral exposure for bilateral decompression had postoperative instability. Despite not being a comparison of the two surgical techniques, **Oertel *et al.*** [(17)] reported that bilateral decompression through a unilateral approach is an adequate technique for decompression caused by lumbar canal stenosis (LCS) in capable hands. **Dohzono *et al.*** [(18)] Postoperative spinal instability was reported is avoided via unilateral microscopic bilateral decompression. These studies all involved more than two levels, and none of them focused solely on one level. Because any decompressive treatment carries the possibility of subsequent instability, which may require further stabilization, long-term Unquestionably, additional research is needed to confirm these conclusions.

CONCLUSION

Those bilateral decompression and unilateral laminectomy techniques is effective and safe procedure for Lumbar Canal Stenosis treatment, with good postoperative outcome.

By all means, unilateral laminectomy for bilateral decompression has a very good result, with the majority of patients reporting significant pain reduction, functional improvement, and patient satisfaction. with good outcome as regard to postoperative back pain. At the beginning, more operative time was needed for bilateral decompression with unilateral laminectomy in comparison with traditional open laminectomy technique, but with time it decreased with improving steep learning curve of the operators.

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