Benha Journal of Applied Sciences (BJAS) **print: ISSN 2356–9751**
Vol. (7) Issue (2) (2022), (89- 95) **online: ISSN 2356–976x**
http://bjas.journals.ekb.eg

Microsurgical Unilateral Approach for Bilateral Decompression of Segmental Lumbar Canal Stenosis

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Abstract:

Lumbar canal stenosis is a common disease with disabling sequences to the patient either due to the disease itself or due to the common surgical procedures which aim to decompress the canal but with much common complications due to removal of the posterior complex (bone and ligaments) of the stenosed segment causing more chance for instability of the spine, much trauma to the other tissues (e.g. muscles of the back on both sides), much scare tissue formation, dead space, postoperative pain and impaired quality of life. The microscopic bilateral decompression by only unilateral laminectomy aims to preserve stability by preserving midline structures like spinous process, intraspinous and supra spinous ligaments and facet joint besides proper dural and foraminal decompression. In this study, it was noticed that this procedure produce proper decompression of segmental spinal stenosis regarding post operative radiological studies, which revealed adequate decompression of the stenosed segment regarding measuring canal cross-sectional area and dimensions both pre and postoperative, and clinically regarding estimating clinical improvement of the patients by estimating low back pain and lower limb pain by visual analogue scale before and after the operation with follow up after one week, 3 months and 6 months, which revealed proper clinical improvement. Patient quality of life was estimated by using Oswestry Disability Index and questionnaire, pre and postoperative after one week, 3 months and 6 months, which revealed proper improvement of the quality of patient life after such procedure.

Key words: Lumbar canal stenosis, microsurgical bilateral decompression, unilateral approach.

1. Introduction

The annual incidence of lumbar spinal stenosis is reported to be five cases per 100,000 individuals. [**1].** Degenerative lumbar spinal stenosis manifests primarily after the sixth decade of life as a result of facet hypertrophy and degenerative disc disease. Congenital stenosis, on the other hand, presents earlier in age with similar clinical findings but with multilevel involvement and fewer degenerative changes. These patients may have subtle anatomic variations of the lumbar spine that may increase the likelihood of thecal sac compression. **(Singh et al. 2005)**

Surgical management is indicated after failure of non-surgical management or rapidly worsening neurological impairment. The traditional approach is a laminectomy with foraminotomy and partial facetectomy**. [20].**

Moreover, biomechanichal studies have stressed the importance of the posterior tension band (the spinous process and the supraspinous and interspinous ligaments) for spinous stability.**[9]**

Unsatisfactory outcomes have been reported in 30% to 40% of patients treated operatively and in 50% to 60% of patients treated conservatively. **[2].**

Failures is attributed to iatrogenic spinal instability after extensive removal of posterior stabilizing structures rather than other causes of failed back surgery syndrome like residual compression, epidural scarring, pseudomeningiocel, arachnoiditis, discitis, nerve root injury or improper diagnosis. **[9]**

Emerging new minimally invasive options, e.g. unilateral laminectomy for bilateral decompression (ULBD), seems to demonstrate a better postoperative outcomes due to its minimal invasiveness. **[20].**

Unilateral approach preserves the facet joints and neural arch of the contralateral side which limits postoperative destabilization and protects the nervous structure against posterior scarring. **[17]**

Although preservation of the stabilizing paravertebral muscles, midline structures, and facet joints may be important for successful management of LSS, sufficient decompression of the neural elements remains the primary goal. The extent of decompression seems to be reflected on the outcome of surgery. **[13]**

2. Aim of the work

The aim of this study is to evaluate the benefit and outcome of the microsurgical unilateral approach for performing bilateral decompression of segmental lumbar canal stenosis.

3. Material and methods:

According to the circumstances of Covid-19 pandemic, which led to canceling all elective surgeries for more than one year at Benha University hospital and Alsahel teaching hospital, the prospective study designed to be on 10 patients of degenerative spine disease from December 2018. All patients were subjected to microscopic unilateral approach for bilateral decompression of segmental canal stenosis.

Inclusion Criteria

- Symptoms and signs of LCS.
- Radiological/neuroimaging evidence of degenerative segmental lumbar stenosis, single level or two adjacent segments (neurologic compression by hypertrophied (infolded) ligamentum flavum, osteophytic facet joints, and / or annular bulging).

- Failure of adequate conservative measures**.**

Exclusion Criteria

- Associated pathology such as instability, inflammation or malignancy.
- History of previous lumbar surgery.
- Traumatic lesions.
- Cauda equina syndrome.
- Patients unfit for surgery.
- > 2 levels of LCS.

Patient assessment: by physical examination, pain evaluation scales (Visual Analogue Score-VAS and functional confidence, Oswestry Disability Index-ODI) and preoperative radiological investigations is to be aquired (X-ray / MRI / …) for all patients and routine preoperative lab investigations . Ethical confirmed consent will be signed from all studied patients. Patients are subjected to microscopic unilateral approach for bilateral decompression of the stenosed lumbar sgment(s). All patients are subjected for postoperative pain evaluation scales (VAS for low back pain and sciatica / ODI) after one week, 3 and 6 months**.** A-P and lateral dimensions (and / or cross-sectional area) of the most stenotic level is measured pre and postoperatively. The mean increase of spinal segments subjected for surgery is to be calculated. (either by Ct or MRI)

Surgical technique of microscopic unilateral approach for bilateral decompression of segmental lumbar canal stenosis:

Midline 3-5 cm skin incision is made according to the level of stenosis (one or two levels) guided by intraoperative C arm fluoroscopy. A linear median fascial incision is made on the patient's most symptomatic side. Separation of the paraspinal muscles from the spinous process and lamina to expose the bony structures. Unilateral self-retaining muscle retractor is inserted. A fenestration is done using Kerrison rongeurs and/or high speed diamond burr. The microscope is used to complete decompression of the spinal canal. Ligamentum flavum and bony stenosing pathology are removed by Kerrison rongeurs until we see the exiting root through the foramen. Care should be paid to spare the pars interarticularis, facet joint and facet joint capsule. After finishing ipsilateral decompression, the microscope is angulated medially and contralaterally to see the opposite side across the midline. The patient is also tilted to the contralateral side (The patient is tied safely to the operating table before starting the operation). Partial removal of the undersurface of the spinous process was performed to get good visualization of the contralateral side safely. Dissecting the anterior surface of the ligamentum flavum from the underlying dura and then the ligament is removed using Kerrison rongeurs from medial to lateral and from cephalad to caudal. At the end of the contralateral decompression, the contralateral exiting root is visualized and its foramen decompression is confirmed by passing a dissector in the direction of the contralateral exiting root. Hemostasis and closure of all layers with subfascial suction drain. **[2].**

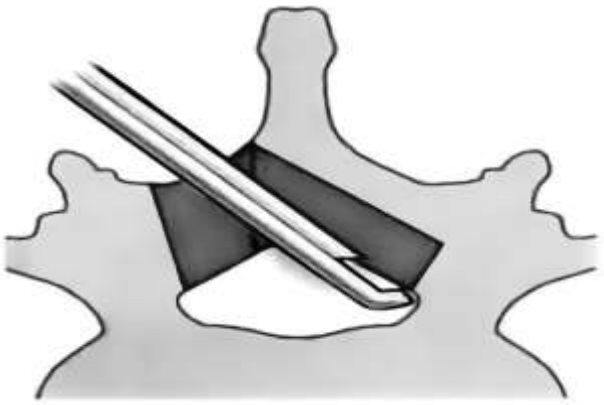

Fig. (1) Diagram showing unilateral hemilaminectomy approach; with undermining of the transverse process to decompress the contralateral neural foramen. Quoted from: **(Siebert et al., 2009).**

The patient was mobilized out of bed without lumbosacral belt at the night of surgery or on the next day morning. The patient was usually discharged after 24 hours and after removal of the wound drain. (2).

4. Results

Our study had included only 10 patients due to the recent circumstances of the covid-19 pandemic, which had caused arrest of all elective surgical procedure in both alsahel teaching hospital and Benha university hospital for more than one year. 40% of patients are males and 60% are females, ages of the patients ranged from 60y to 29y with a mean age of 47.2y. All the ten patients underwent microscopic bilateral decompression of lumbar canal stenosis by unilateral approach. 8 of these patients operated for L4/L5 level, one for L5/S1 and one for L3/L4. Regarding low back pain, VAS improved from 7.9 to 3 6months postoperatively (table 1), lower limb pain, the mean VAS improved from 8.3 to 2.6 postoperative (table2), and regarding the quality of life, the mean ODI

improved from 45.2% to 19.5% after 6 months (table3).

Table (1) Ranges and Average values of low back pain (measured by VAS) and percentage of change.

	Range			Average	Percent of change
	Min	-	Max		
Pre op	7	-	10	7.9	-
Post op 1st w	0	-	6	5	36.7% improvement
Post op 3 m	0	-	6	3.3	58.2% improvement
Post op 6 m	0	-	6	3	60% improvement

Table (2) Ranges and average values of lower limb pain (measured by VAS) and percentage of change.

	Range			Average	Percent of change
	Min	-	Max		
Pre op	6	-	10	8.3	-
Post op 1st w	0	-	5	3.9	53% improvement
Post op 3 m	0	-	6	2.6	71% improvement
Post op 6 m	0	-	6	2.6	71% improvement

Table (3) Ranges and average values of ODI and percentage of change.

	Range			Mean	Percent of change
	Min	-	Max		
Pre op	22%	-	77%	45.2%	-
Post op 1st w	10%	-	50%	22.8%	22.4% improvement
Post op 3m	10%	-	54%	19.4%	25.8% improvement
Post op 6m	10%	-	62%	19.5%	25.7% improvement

Regarding the radiological measurements mean values

The mean preoperative AP dimension of the concerned stenosed segments: (10.9mm), while the mean postoperative: (16.9mm) with a mean percent of increase (55%). The mean preoperative lateral dimension of the concerned stenosed segments: (13.8mm), while the mean postoperative: (19.6mm) with a mean percent of increase: (42%). The mean preoperative cross-sectional area (CSA) of the concerned stenosed segments were (76.9mm^2), while the mean postoperative: (274.8mm^2) with a mean percent of increase: (257.3%).

Complications

Only one patient, suffered from failed back syndrome and instability after temporary relief and needed reoperation and fixation by the traditional method. There were no recorded other complications such as, infection, hemorrhage, CSF leak or postoperative neurological new deficit in our series.

Observation of clinical results of patients after surgery and the ratio of CSA increased after surgery, we noticed that in most of the patients, clinical improvement after surgery was not related to the change in CSA in the radiological follow up, although some cases have much increase in CSA after surgery that was not accompanied with the best clinical improvement and vice versa. This couldn't be proved statistically due to the few numbers of cases.

5. Discussion

Commonly used techniques of exposure for lumbar decompression that include elevation of the multifidus bilaterally with subsequent wide retraction have potentially serious consequences. **[10]**

Mayer et al. [18] demonstrated a decrease in paraspinal muscle strength with concomitant atrophy on postoperative computed tomography scans after conventional open surgical spinolaminectomy. **See and Kraft [27]** echoed these concerns in their observation of chronic denervation and electromyographic abnormalities of the paraspinal muscles 4 years after open surgery. **Sihvonen et al. [28]** noted similarly computed tomography and electromyographic abnormalities and correlated these with the postoperative failed back syndrome. Retraction of multifidus beyond the midpoint of the facet joint tethers the medial branch within the mamilloaccessory groove, risking muscular denervation. The described techniques of microdecompression limits ipsilateral retraction to the level of the medial facet border. Contralaterally, no elevation or retraction of the paraspinal musculature is undertaken, thereby minimizing the risk of iatrogenic muscular trauma and thereby proving to be an important tool in decreasing the risk of these undesirable sequelae. **[10]**. Most surgical approaches to decompression involve excision of the interspinous or supraspinous ligament complexes, altering an already pathologic biomechanical milieu. Loss of the midline supraspinous/interspinous ligament complex can lead

to a loss of flexion stability, thereby increasing the risk of delayed spinal instability. **[24, 25]. Goel et al., [12]** found that, under normal conditions, the supraspinous ligament experienced the greatest force when exposed to an external flexion moment across an anatomic segment. **Hindle et al. [13]** also demonstrated load with flexion in the supra- and interspinous ligaments. The supra- and interspinous ligaments resist 19% of flexion forces, with the facet capsular ligaments resisting 39%. **[4] Adams and Hutton [4]** have also suggested that the muscular attachments to the posterior arch and the insertions of the muscular slips on the facet capsule brace the facets, improving their ability to resist displacement. Besides, complete decompression may not be necessary to achieve symptomatic relief as previously suggested by **Aryanpur and Ducker [7], Thomas et al. [22]** reported a statistically significant increase in dural sac size after laminotomy or laminectomy but found no statistical relationship between the extent of decompression and clinical outcome. It may only be necessary to bring the patient below a symptomatic threshold. Indeed, in one of the only studies correlating the degree of radiographic with clinical outcome, it was observed that the satisfaction of patients with the results of surgery (e.g., Oswestry score and walking capacity) was more important in surgical outcome than the degree of decompression as seen on a postoperative CT scan **[28].** Clinical improvement is not related to the change in CSA in radiological features, **Anasuya et al., [6]** concluded that even in symptomatic Patients, normal diameter of the spinal canal was noticed in (32%) cases. Even in asymptomatic cases canal narrowing was noticed. Most of the symptomatic cases had normal Cross-sectional area. Detailed history and clinical examination of the patient along with the radiological investigation of stenosis with MRI scan, will establish the diagnosis. 3 cases of our study had CSA>100, although they had significant clinical manifestation of lumbar canal stenosis, they even had the worst pain in our series assisted by VAS. It was also noticed that the clinical improvement after surgey in our series was not related to the change in CSA.

Postsurgical dead space may has serious potential consequences. Increased volume to be filled results in increased blood loss and provides an ideal bacterial culture medium with potential for increasing the infection rate. The region is inevitably replaced with scar tissue, thereby complicating or necessitating secondary surgical interventions. Resection of portions or all of the spinous processes, interspinous ligaments, and supraspinous ligaments, and iatrogenic damage to the paraspinal musculature results in a large volume of dead space. Dead space and its consequent risks are significantly decreased using the described technique, microscopic unilateral approach for bilateral decompression of lumbar canal stenosis. **[31]**. Unilateral approach for bilateral decompression for lumbar canal stenosis preserves much of these complexes, aiming for better stability of the spine, less scare formation and less postoperative complications with satisfactory lumbar canal decompression. Our study had included only 10 patients due to the recent circumstances of the covid-19 pandemic. Most patients (90%) showed satisfactory improvement regarding their quality of life, as measured by Oswestery Disability Index, and improvement of their complain regarding pain, as measured by VAS score. These results are in agreement with the results obtained by **Aboulmaaty and Elmolla [7]** who reported 95% satisfaction for the same operation, while **Abbas et al., [1]** reported no significant differences regarding VAS score and ODI, between unilateral microscopic approach for bilateral neural decompression in lumbar spinal stenosis and the conventional laminectomy method. Regarding the available postoperative data, and after comparison with the preoperative data, the performed procedure had achieved mean increase of CSA by about 257.3%, AP dimension by about 55%, and the lateral dimension by about 42%. Regarding the clinical outcome, the mean VAS score for the low back pain improved by about 36.7%, 58.2% and 62% after one week, three months and six months respectively. While the mean VAS score for lower limb pain improved by about 53%, 71% and 71%, after one week, three months and six months respectively. The mean record of Oswestery Disablity Index (ODI) improved by about 22.4%, 25.8% and 25.7% after after one week, three months and six months respectively. This is due to the adequate decompression of the concerned stenosed segment bilaterally by the aid of surgical microscope, with preservation of the supraspinous/interspinous ligament complex, the posterior spinous process and the contralateral lamina, also less surgical trauma for other tissues such as muscles of the other side and smaller skin incision. As the traditional standard operation in lumbar spinal stenosis is; spinous processes, vertebral lamina, ligamenta flava, and parts of the facet joints are ablated during this removal of the roof of the spinal canal. **[8].** In a meta-analysis, for estimating the success rate of the conventional open bilateral decompression laminectomy, this procedure has been shown to be merely 64% **[26]**; lack of success was partly attributed to the development of postoperative instabilities. Nerve compression is usually limited to the height of the intervertebral space in the area of the hypertrophied joint facets and the ligamentum flavum. Removing long sections is therefore not necessary, which has – aided by enormously increasing numbers of surgical procedures – resulted in the development of newer, less invasive technique. **Thome et al., [8]**

6. Case presentation

Personal history:

Female patient aged 56 years old, no hypertension, not diabetic.

Complain:

Low back pain, bilateral lower limb pain and claudication.

Present history:

Complain started from one year ago, gradual onset, progressive course and neurogenic claudication of about 100 meters.

VAS score of lower limb pain:

8/10 for both lower limbs

VAS score of low back pain: 9/10

Preop Oswestry Disability Index: 32%

Result of examination:

No apparent motor deficit, normal muscle tone and reflexes, intact sensation.

Preop radiological findings:

MRI lumbosacral showed L4/L5 lumbar canal stenosis.

CSA of the stenosed level: 56.6mm^2

Dimensions of the stenosed level: AP: 10.7mm Lat:18.5mm

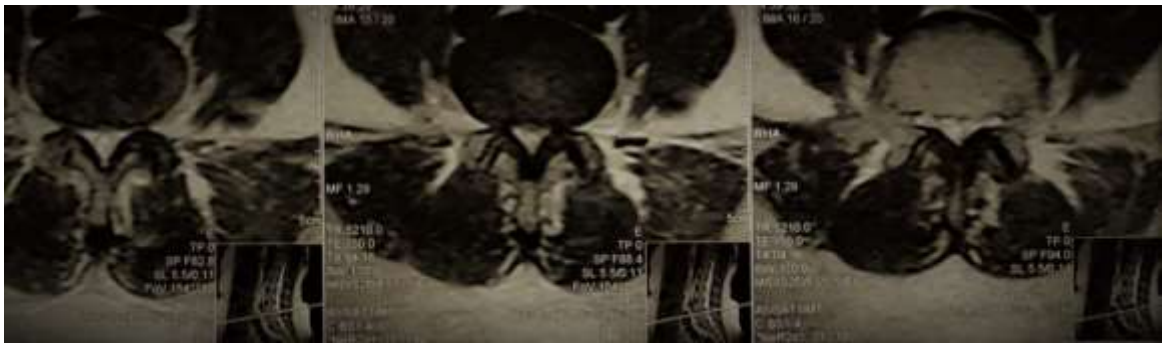

Fig. (2) preoperative axial Lumbosacral MRI, cuts through L4/L

Fig. (3) Preoperative sagittal Lumbosacral MRI

Operation done:

L4/L5 microscopic bilateral decompression by unilateral approach.

Follow up postop:

Patient had marked postoperative improvement regarding low back pain, lower limb pain and claudication distance.

VAS score of low back pain postop:

post op 1st week: 4 3 months: 5 6 months: 4

VAS score of left lower limb pain post op:

post op 1st week:4 3 months: 3 6 months: 2

ODI post op:

1week: 22% 3months: 14% 6months: 13%

Post op radiology CT:

CSA: 398.2 mm^2 AP: 27 mm Lateral: 30.4 mm

Fig. (4) postop axial Ct of L4

7. Conclusion

Microscopic unilateral approach used for bilateral decompression of lumbar canal stenosis, is an effective procedure for management of segmental lumbar canal stenosis with satisfactory results, favorable outcome and less complications.

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