Clinical Article

Online ISSN : 2314-8969
Print ISSN: 2314-8950

Egy Spine J 24:42-49, 2017

www.esa.org.eg

Efficacy and Safety of Using Unilateral Approach for Bilateral Neural Decompression in Lumbar Spinal Stenosis

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Abstract

Background Data: Lumbar spinal stenosis refers to the anatomical narrowing of the lumbar spinal canal, and is associated with a spectrum of clinical symptoms. The annual incidence of lumbar spinal stenosis is reported to be five cases per 100,000 individuals.

Purpose: The purpose of this study is to evaluate the surgical outcome of patients having lumbar spinal stenosis and underwent unilateral approach for bilateral spinal decompression surgery, and to compare outcomes with the conventional laminectomy approach.

Study Design: This is a prospective randomized controlled study.

Patients and Methods: This study included 21 patients with clinically manifest disco-ligamentous lumbar spinal stenosis without radiological instability. Eleven patients had bilateral neural decompression through a unilateral microscopic approach (unilateral laminectomy) (Group-I) and the other 10 patients had conventional laminectomy (Group-II).Clinical assessment was done using Visual Analogue Scale (VAS) and ODI. The patients were followed-up for 12 months postoperatively.

Results: Thirteen patients were females and 8 were males. The mean age of unilateral approach group was 47.2 years, and 49.5 years for the conventional group. Reported duration of surgery was 100 minutes in group-I and 85 minutes group-II. Reported intraoperative blood loss was 84.7 cc in group-I, and 127 cc in group-II. Clinical improvement was achieved in both groups without significant difference in between regarding VAS and ODI. In group we reported unintended durotomy occurred in two patients, CSF leak in one patient, and hematoma in another patient. In group-I we had one patient of unintended durotomy, one patient had CSF leak, and one patient developed spondylolisthesis.

Conclusion: Unilateral microscopic laminoforaminotomy with cross over the top technique, for bilateral neural decompression in lumbar spinal stenosis has equal efficacy and safety with minimal effect on stability and slight better postoperative back pain in comparison to conventional approach. (2017ESJ140)

Keywords: unilateral approach, conventional laminectomy, hemilaminectomy, lumbar spinal stenosis, microscopic discectomy

Received on:
July 2nd, 2017

Accepted on:
September 21th, 2017

Introduction

Lumbar spinal stenosis refers to the anatomical narrowing of the lumbar spinal canal (LSS), and is associated with a spectrum of clinical symptoms. The annual incidence of lumbar spinal stenosis is reported to be five cases per 100,000 individuals.[18] The characteristic symptom of LSS is neurogenic claudication due to localized bony and/or discoligamentous narrowing of the spinal canal.[7,16] Factors responsible for the development of LSS include disc degeneration resulting protrusion with ventral narrowing of the canal and with consequent narrowing of the lateral recess and neural foramen. Biomechanically, this affects ligamentous laxity with subsequently increased segmental mobility and additional strain on the facet joints.[4,19] Bone structures react to this subclinical instability with osseous hypertrophy, which presents as hypertrophy of the facet joints. The ligamentum flavum shows fibrotic hypertrophy in addition to folding inwards due to height loss.[19] Lastly, these reactive processes do not succeed in stabilizing the segment, disc degeneration and laxity of capsules and ligaments may result in the manifest instability of spondylolisthesis.[19] These pathoanatomical changes result in nerve root compression, which is affected by the position of the spine. Narrowing can be well localized at three different anatomic structures, like the central canal, lateral recess, or the neural foramina.[8]

Surgery for decompression of LSS is indicated when medical conservative treatment fails in absence of neurological deficit, or with the presence appearance of neurological deficit (motor or sphincteric).[20] The surgical treatment of bilateral sciatica in LSS aims to decompress the entrapped neural elements without disruption of stability of the affected segment.[3] Decompressive surgical procedures can be achieved through bilateral laminectomy, a full hemilaminectomy and a unilateral partial hemilaminectomy, any procedure of these can be done with or without discectomy.[2]

Traditional laminectomy has many postoperative complications, such as continued back pain (failed back syndrome), atrophy of paraspinal muscles, and postoperative scarring, which can lead to poor results as renewed nerve compression, and delayed segmental instability especially with patient aging more than 60 years.[6,13] A unilateral laminectomy was recently proposed for the management of bilateral neural decompression; its advantages are less tissues trauma, preserving the facet joints and neural arch of the contra-lateral side, limits postoperative destabilization, and protects the nervous structures against postoperative scarring (Figure 1).[18] The microscopic unilateral laminectomy aims to preserve stability by preserving midline structures like spinous process, intraspinous and supra spinous ligaments and facet joint besides Dural and foraminal decompression.[1]

The purpose of this study is to evaluate the surgical outcome of patients having lumbar spinal stenosis who underwent unilateral approach for bilateral decompression surgery, and to compare outcomes between this approach and the bilateral conventional approach for bilateral neural decompression.

Patients and Methods

This is a prospective randomized controlled study including 21 patients. Patients were divided randomly into 2 groups. Group I included 11 patients who were operated by a unilateral approach for bilateral microscopic decompression. Group II included 10 patients who were operated by conventional laminectomy.

Twenty one consecutive patients, admitted to Alexandria main university hospital, during the period from January till June 2016, were included in the study. All patients had the diagnosis of single segmental L4-L5 lumbar canal stenosis. Inclusion criteria were: bilateral claudicating sciatica, evidence of bilateral nerve root compression (lumbar spinal stenosis) in MRI, failure of conservative management for more than 6 months, and/or the presence of progressive neurological deficit. Exclusion criteria included: segmental instability, sphincteric affection, associated pathologies and infection.

All patients were evaluated preoperatively both generally and neurologically. Back and leg pain was assessed using Visual Analogue Scale (VAS). Functional status and state of disability were

assessed using ODI. MRI of the lumbosacral spine was obtained in all patients. Also, plain X-rays in standard (AP and lateral), oblique and stress views (flexion & extension) were done to exclude instability. All patients had routine laboratory investigations for general surgery and were operated upon under general anesthesia in the prone position.

In the unilateral approach, the procedure started with a midline skin incision over the target level. Afterwards, the fascia was incised in a C-shaped fashion and reflected towards the midline, with subsequent unilateral sub-periosteal dissection of the muscles. Using the microscope, bone removal starts with cutting (using drill or rongeurs) of the lamina medially and going laterally without jeopardizing the pars. The cranial limit of laminectomy is the end of the ligamentum flavum. Cutting the upper edge of the caudal lamina is done for complete removal of ligamentum flavum. The ipsilateral ligament is removed from medial to lateral followed by lateral recess decompression and foraminotomy on the same side. Dealing with the contra-lateral side starts with undermining the spinous process. Tilting the operating table15-20 degrees contra-laterally puts the lateral recess in the line of view. (Figure 2,3)

In the bilateral approach (conventional laminectomy) the procedure starts with a midline skin incision over the target level. Afterwards, the lumbar fascia is incised vertically. The paraspinal musculature is detached bilaterally from the spinous process and laminae in a sub-periosteal fashion and then bilaterally retracted. Decompression is performed using standard techniques to remove the spinous process, lamina, and ligamentum flavum along with partial medial facetectomy (limited to one-third of the facet joint).

Postoperatively all patients were followed up at 1 month & 12 months for clinical evaluation. Clinical outcomes were assessed using VAS (for assessing back and leg pain) and ODI in addition to radiological follow up for 12 months postoperatively.

Results

The study included 21 patients with clinically manifest disco-ligamentous lumbar spinal stenosis; in the form of back pain & bilateral claudicating sciatica, without radiological instability. All patients had the diagnosis of single segmental L4-L5 lumbar canal stenosis. Eleven patients had bilateral neural decompression through a unilateral microscopic approach (unilateral laminectomy) (Group-I), and the other 10 patients had conventional laminectomy (Group-II). 13 patients were females and 8 were males. The age of the patients was 47.2±10.78 years (Range, 33-69 years) in group-I, and 49.5±10.32 years (Range, 36-71 years) in group-II (Table 1).

Intraoperative blood loss was 84.73±24.19 cc (Range, 50-150 cc) in group-I, and 127.0±26.17 cc (Range, 100-350 cc) in group-II. The duration of surgery in group-I was 100±0.01 minutes (Range, 90-120 minutes), and 85±0.01 minutes (Range, 60-110 minutes) in group-II (Table 2).

Preoperative disability assessment using ODI was comparable in the 2 groups; in group-I the mean ODI was 28.7±5.93, and in Group-II the mean ODI was 28.05±8.33 (Table 2). Clinical improvement was achieved in both groups; regarding back and leg pain. Again, postoperative ODI was comparable in the 2 groups after 1 month and after 12 months postoperative; in group-I the mean ODI was 5.55±5.08 after 1 month, and 6.5±5.67 after 12 months postoperative, and in group-II the mean ODI was 6.5±5.30 after 1 month, and 7.1±5.67 after 12 months postoperative (Table 3). There was a statistically significant difference when comparing the preoperative to postoperative leg pain VAS in both groups (P=0.001). However there was no difference when comparing the leg pain VAS at 1 and 12 months follow up between both groups. (Table 4) According to back pain VAS, there was on significant difference between preoperative back pain in both groups. After one month follow up; there was slight difference in back pain in favor of the unilateral group although insignificant. This difference decreased at 12 months follow up but again still in favor of the unilateral group. (Table 5)

In Group-I; morbidity included unintended durotomy occurred in two patients (18.2%) that were repaired intraoperatively, however CSF leak occurred in one patient (9.1%), but was managed conservatively till it stopped after 1 week, and hematoma in another patient (9.1%). In Group-II; one patient (10%) had unintended durotomy, again

was repaired intraoperatively. However he still had CSF leak, and was managed conservatively till it stopped after 10 days. Another patient (10%) had spondylolisthesis; that needed further surgery for internal stabilization and inter-body fusion.

Table 1. Distribution of the Studied Patients According to Age

Age	Unilateral Group (N=11)		Conventional Group (N=10)	
	No.	%	No.	%
30 -	2	18.1	1	10
41 -	3	27.2	2	20
50 -	3	27.2	3	30
60>	3	27.2	4	40
Mean±SD	47.2±10.78 (33–69)		49.5±10.32 (36–71)	

Table 2. Comparison between both Groups According to Duration of Surgery and Blood Loss

Parameters		Unilateral Group (N=11)	Conventional Group (N=10)	Test of significance
Duration of surgery/ (minutes)	Mean±SD	100±0.01(90.0–120.0)	85±0.01(60.0–110.0)	$^{MW}P=0.028^{*}$
	Median	110.0	95.0	
Operative blood loss/ (cc)	Mean±SD	84.7±24.2(50.0–150.0)	127.0±26.17(100.0–350.0)	$^{MW}P=0.073^{*}$
	Median	84.73	137.0	

P: p value for comparing between the two studied groups.

MW: Mann Whitney U test.

*: Statistically significant at P≤0.05

Table 3. Comparison between both Groups According to Preoperative ODI

Parameters		Unilateral Group (N=11)	Conventional Group (N=10)	P
Preoperative	Mean±SD	28.7±5.93(19.0–42.0)	28.05±8.33(12.0–42.0)	0.340
One moPostOp	Mean±SD	5.55±5.08(0.0–17.0)	6.5±5.30(0.0–17.0)	0.072
12 mosPostOp	Mean±SD	6.5±5.67(0.0–17.0)	7.1±5.67(0.0–19.0)	0.085

P: p value for comparing between the two studied groups.

*: Statistically significant at p ≤ 0.05.

Table 4. Comparison between both Groups According to Leg Pain VAS

Parameters		Unilateral Group (N=11)	Conventional Group (N=10)	P
Preoperative	Mean±SD	9.04±0.99	8.98±0.92	0.807
One mo PostOp	Mean±SD	1.38±1.31	1.82±1.11	0.061
12 mos PostOp	Mean±SD	1.46±1.49	1.66±1.69	0.071

P: p value for comparing between the two studied groups.

*: Statistically significant at p ≤ 0.05.

Table 5. Comparison between both Groups According to Back Pain VAS

Parameters		Unilateral Group (N=11)	Conventional Group (N=10)	P
Preoperative	Mean±SD	5.42±1.99	5.61±1.92	0.093
One mo PostOp	Mean±SD	2.82±1.34	4.62±1.51	0.060
12 mos PostOp	Mean±SD	1.96±1.59	2.36±1.80	0.062

P: p value for comparing between the two studied groups.

*: Statistically significant at p ≤ 0.05.

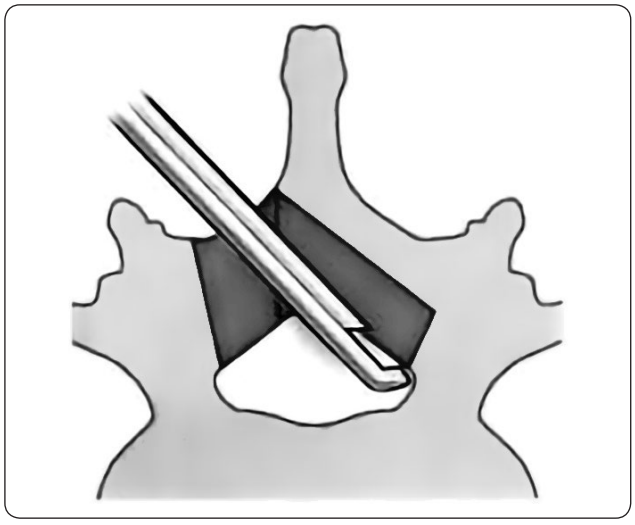

Figure 1. Diagram showing unilateral hemilaminectomy approach; with undermining of the transverse process to decompress the contralateral neural foramen.[18]

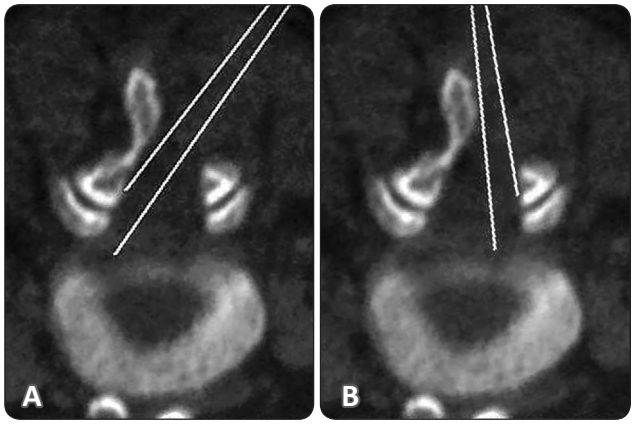

Figure 2. Tilting the table 15-20 degrees brings the zone of foramen and lateral recess into view.[15]

Figure 3. Left: Preoperative axial MRI showing focal L4-5 stenosis. Right: Postoperative axial CT scan showing left unilateral fenestration with undermining of the spinous process (cross over the top) to reach the contralateral side, with minimal bone removal.

Discussion

The bilateral approach (conventional laminectomy) together with partial facetectomy and foraminotomy gives maximal neural decompression. However, bilateral muscle stripping with removal of the posterior bony arch and midline stabilizing ligaments (supraspinous and interspinous) causes morbidity in the form of delayed back pain and possibility of destabilizing the motion segment (spondylolisthesis). A minimally invasive technique (unilateral approach) has evolved to lessen morbidity, also pointing to the great value in maintaining the posterior elements together with preventing spondylolisthesis. [2-4,7,8,9,11,13,15,16,18-20]

Our study included 21 patients, the age of the patients ranged from 33 to 69 years (Mean 47.2 years) in the unilateral approach group, and 36 to 71 years (Mean 49.5 years) in the conventional laminectomy group. This result does not coincide with the result by Cavusoglu et al,[5] in their series with age group of lumbar spinal stenosis ranged from 55-83 years (Mean age 69 years) years. Also, Ng et al,[13] found the age of patients ranged from 52 to 82 years (Mean age 62 years). The affection of younger mean age group in our study may be due to that most of our patients suffered from disco-ligamentous stenosis which occurs in a younger age group than bony stenosis which occurs in older age group as in other studies, due to lack of exercise and over weight in most of Egyptian population.

In our study, the duration of surgery in the unilateral approach group ranged between 90 to 120 minutes (Mean 100 minutes), and from 60 to 110 minutes (Mean 85 minutes) in conventional laminectomy surgery. This was in agreement with Shabat et al,[17] who stated that the mean surgical time was 79 minutes for conventional surgery. Again, our results coincide with the result by Usman et al,[21] who stated that the mean surgical time was 62 minutes for conventional laminectomy, and mean surgical time was 69 minutes for unilateral laminectomy. The intraoperative blood loss ranged from 50 to 150 cc (Mean 84.73 cc) in unilateral approach, and from 100 to 350 cc in conventional laminectomy surgery (Mean 127 cc). These results coincide with the result by Yaman O et al,[22] who had 238 cc average

blood loss in conventional laminectomy (Range, 200 to 300 cc), while average bleeding was 90 cc in unilateral approach (Range, 50 to 150 cc). Amount of blood lost was higher for classical laminectomy than bilateral laminectomy via unilateral approach.

In this study, the patient symptoms were assessed using the Visual Analogue Scale. In this study, there was a statistically significant difference in the two studied groups between preoperative VAS and postoperative VAS (P=0.001). Also, there was a statistically significant difference on comparing preoperative VAS and 12 months after surgery in the two groups (P=0.001). This result was in agreement with Cavusoglu et al,[5] who stated that most of the changes in VAS occurred between preoperative and early follow-up assessment.

Regarding intraoperative complications in patients having unilateral approach surgery: two patients (18.2%) had intraoperative unintended durotomy, while in the patients having bilateral laminectomy: one patient (10%) had intraoperative unintended durotomy. Podichetty et al,[14] did minimally invasive decompression and found that intraoperative unintended durotomy occurred in 4.5% of patients. Cavusoglu et al,[5] did microscopic unilateral laminectomy and stated that unintended durotomy occurred in 5-15%. While Ng et al,[13] did open lumbar decompression surgery and recorded unintended durotomy in 14% of the patients.

Regarding postoperative complications, in the eleven patients operated by unilateral laminectomy: two patients (18.2%) had early postoperative complications; CSF leak occurred in 1 patient (9.1%), and early hematoma occurred in 1 patient (9.1%). There were no late postoperative complications. In patients operated by conventional laminectomy: one patient (10%) had early post-operative complication in the form of CSF leak, while one patient (10%) had late postoperative complication in the form of spondylolisthesis, and needed fixation and inter-body fusion. Nackai et al,[12] reported that postoperative instability ranged from (2-6.7%) in literature, while in their study done through wide fenestration laminectomy, it was (1.5%).

Conclusion

Unilateral microscopic laminoforaminotomy with cross over the top technique, for bilateral neural decompression in lumbar spinal stenosis has equal efficacy and safety with minimal effect on stability and slight better postoperative back pain in comparison to conventional approach.

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الملخص العربي

تقييم المنهج الجراحي أحادي الجانب في تخفيف الضغط ثنائي الجانب على الأعصاب مقابل المنهج ثنائي الجانب في العلاج الجراحي لحالات ضيق القناة الشوكية القطنية

البيانات الخلفية: ضيق القناة العصبية القطنية هو الضيق التشريحي للقناة الشوكية. تعتبر التقلصات العصبية هي العرض الرئيسي لهذا المرض.

الغرض: مقارنة المنهج الجراحي أحادي الجانب في تخفيف الضغط ثنائي الجانب على الأعصاب مقابل المنهج التقليدي في علاج حالات ضيق القناة الشوكية القطنية.

تصميم الدراسة: دراسة مستقبلية، اشتملت 21 مريضا تم تشخيصهم بضيق القناة القطنية بقسم جراحة المخ والأعصاب؛ كلية الطب، جامعة الإسكندرية .تم تقسيمهم عشوائياً إلي مجموعتين. الأولي ستخضع للجراحة التقليدية والثانية ستخضع للجراحة أحادية الجانب باستخدام الميكروسكوب الجراحي.

المرضي والطرق: تم اختيار جميع المرضى من قسم جراحة المخ والأعصاب؛ كلية الطب؛ جامعة الإسكندرية في الفترة من يناير إلى يونيو 2016. تم أخذ التاريخ المرضى والتقييم الأكلينيكي للمرضي. والتقييم باستخدام مقياس التماثل البصري (VAS)، وتم عمل أشعات عادية ديناميكية ورنين مغناطيسي لكل المرضى قبل إجراء الجراحة. تم إجراء الجراحة للحالات التي بها ضيق القناه العصبية على الناحيتين، بين الفقرتين القطنية الرابعة والخامسة. تمت عملية استئصال الصفيحة القطنية من ناحية واحدة في 11 حالة، وتم التوسيع على الناحيتين باستئصال كلي للصفيحة في 10 حالات. تمت المتابعة لمدة عام بعد التدخل الجراحي لكل الحالات. وشمل التقييم ما بعد الجراحة على إعادة تقييم أعراض ما قبل الجراحة لجميع المرضى، وإعادة التقييم باستخدام مقياس التماثل البصري (VAS) وكذلك تم عمل أشعة عادية لجميع المرضى لتقييم مقدار ثبات العمود الفقري.

النتائج: كانت جميع الحالات تعاني من آلام بالظهر وآلام عرق النساء. متوسط زمن الجراحة في حالات استئصال الصفيحة القطنية من ناحية واحدة 106 دقيقة. وفى عملية الاستئصال الكلى للصفيحة كان متوسط زمن الجراحة 77.7 دقيقة. في عملية استئصال الصفيحة من ناحية واحدة وجد أن متوسط فقد الدم 102سم^3، بينما كان المتوسط 156.2 سم^3 أثناء الجراحة التقليدية.

أثبتت الدراسة أن هناك اختلاف ذو دلالة إحصائية بين معامل مقياس التماثل البصري (VAS) قبل الجراحة وبعد الجراحة وأثناء فترة المتابعة في المجموعتين. بالنظر إلى المضاعفات أثناء الجراحة في عملية استئصال الصفيحة من ناحية واحدة حدت حالتين لقطع الأم الجافية. وبالنسبة لما بعد العملية مباشرة حدثت حالة واحدة لتسرب السائل النخاعي، وتجمع دموي في حالة أخري. ولم تعاني أي من حالات تلك المجموعة من ظهور انزلاق فقاري طوال فترة المتابعة. أما بالنسبة لحالات الاستئصال الكلى للصفيحة، حدث قطع بالأم الجافية في حالة واحدة. وحدث تسرب للسائل النخاعي في حالة في فترة المتابعة الأولى. بينما كانت المضاعفات المتأخرة بعد عام من الجراحة وجود انزلاق ففاري مع وجود الآم بأسفل الظهر في حالة واحدة.

الاستنتاج: من هذه الدراسة يمكن أن نستنتج أن عملية المنهج الجراحي أحادي الجانب في تخفيف الضغط ثنائي الجانب على الأعصاب لحالات ضيق القناة العصبية القطنية لها نفس التأثير على كفاءة رفع الضغط عن الأنسجة العصبية والنخاع الشوكي وتخفيف الأعراض المرضية بصورة آمنه مثل الجراحة العادية وضرر أقل على ثبات العمود الفقري.