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Unilateral Laminotomy versus Conventional Laminectomy in Treatment of Lumbar Canal Stenosis: A Prospective Comparative Study

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ABSTRACT

Background Data: Lumbar spinal stenosis is common in elderly and obese patients. Surgical intervention should be considered only after all conservative treatment options have been proven unsuccessful. Wide laminectomy was the gold standard of treatment, but surgical failures have been reported. Recently, a less invasive decompressive surgical procedures have emerged as an alternative technique.

Purpose: To compare between the unilateral laminotomy approach and conventional laminectomy approach for the treatment of lumbar canal stenosis, regarding clinical outcomes.

Study Design: This is a prospective clinical randomized controlled study.

Patients and Methods: This study included 30 patients with lumbar canal stenosis. 15 patients underwent unilateral laminotomy approach (Group A), while the other 15 patients underwent conventional laminectomy approach (Group B). Surgical operative time, blood loss, and hospital stay were recorded. Clinical outcomes have been assessed by Visual Analogue Scale (VAS) of leg pain and Oswestry Disability Index (ODI). Patients were followed up for 1 year postoperatively.

Results: Male to female ratio was 12:18 patients. The mean age was 52.5±6.62 years in Group A and 52.2±7.24 years in Group B. The mean operative time was 73.5±14.54 minutes in Group A and 85.5±17.07 minutes in Group B. Less blood loss was recorded in Group A (127±37.43 ml) than Group B (152±50.95 ml). Three patients suffered unintended durotomy in both groups and no postoperative CSF leak occurred. Marked reduction of VAS and ODI was achieved in both groups at one-year follow-up without statistically significant difference.

Conclusion: Unilateral laminotomy approach used for bilateral neural compression is an effective technique for treatment of lumbar canal stenosis in comparison to conventional laminectomy approach. (2019ESJ184)

Keywords: Lumbar canal stenosis, Unilateral laminotomy, Conventional laminectomy

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INTRODUCTION

Lumbar spine stenosis (LSS) is the narrowing of the spinal canal compressing the nerves traveling through the lower back into the legs. Narrowing can be localized at the central canal, lateral recess, and neural foramina. LSS is common in elderly and obese patients. Disc degeneration, ligamentum flavum hypertrophy, facet hypertrophy, and bone osteophytes are the main factors for the spinal canal to narrow. Neurogenic claudication is the main complaint in those patients.[3] A conservative approach should be the initial line of treatment. This may include non-steroidal anti-inflammatory medication, analgesics, physical therapy, and epidural steroid injections. Surgical intervention should be considered only after all conservation treatment options have been proven to be ineffective.[3]

Wide laminectomy combined with undercutting of medial facet with foraminotomy was the gold standard surgical line of treatment. Surgical failures were observed after conventional laminectomy. This was attributed to muscle denervation with prolonged retraction of the multifidus muscle, resulting in chronic low back pain postoperatively. Moreover, delayed spinal instability has been suggested as a potential factor of poor outcome.[1]

In recent years, procedures such as microscopic laminotomy, fenestration, and laminoplasty were considered to be less invasive than the standard laminectomy. The less invasive decompressive surgery has emerged as an alternative technique, sparing important anatomical structures and decreasing the risk of postoperative spinal instability.[1]

The aim of this study is to compare between the unilateral laminotomy approach and conventional laminectomy approach for treatment of lumbar canal stenosis, regarding surgical and clinical outcomes.

PATIENTS AND METHODS

This is a prospective randomized controlled clinical study conducted on 30 patients suffering from lumbar canal stenosis, during the period from May 2017 to April 2018. The patients were divided into two groups, 15 patients each. Group A underwent a less invasive unilateral laminotomy approach and Group B was treated by conventional laminectomy approach.

Inclusion criteria included the following: the age in both sexes ranging from 40 to 70 years; symptomatic LCS with radiculopathy and/or neurogenic claudication; one level or two levels of stenosis; failure of conservative measures for 3 months. Exclusion criteria were as follows: spinal instability and/or spondylolisthesis and previous lumbar surgery.

Full history of the patients was taken and recorded, and they were subjected to general and neurological examinations. All patients underwent routine laboratory investigations, plain X-ray with dynamic views to exclude instability, and MRI of the lumbosacral spine.

Surgical Techniques

All patients were submitted to general anesthesia and underwent operation in the knee-chest position; the abdomen was free with cotton pads on pressure points. The back of the patient was sterilized with betadine and sterile towels were placed. A skin incision was made according to the level of stenosis guided by intraoperative C-arm fluoroscopy.

Unilateral Laminotomy Approach. A unilateral self-retaining retractor was inserted after dissection of the paraspinal muscles on one side, with preservation of supraspinous and interspinous ligaments and exposing the underlying bony structures. A small opening of the lamina was done from medial to lateral and complete excision of the ipsilateral ligamentum flavum was done using the Kerrison rongeurs. To deal with the contralateral side, the operating table was tilted contralaterally to put the opposite lateral recess

in line of view with the microscope covered by full sterile drape. Then the anterior surface of contralateral ligamentum flavum was dissected from the underlying dura and removed from medial to lateral and cephalocaudally until the contralateral exiting nerve root was visualized. Hemostasis and closure without drainage were performed (Figure 1).

Conventional Laminectomy Approach. The paraspinal muscles were detached bilaterally and retracted. Open conventional standard technique (without using the microscope) has been used to decompress the spinal canal by removing the spinous process, lamina, and ligamentum flavum with undercutting of the medial facet and foraminotomy. Adequate hemostasis and meticulous wound closure after the insertion of suction drain were done (Figure 2).

Postoperatively, all patients received prophylactic intravenous antibiotics for 48 hours and analgesics. They were encouraged for early mobilization and discharged as soon as possible, as long as there were not any reported adverse events or complications.

Outcome Measures

Clinical outcome parameters including operative time, intraoperative blood loss, intraoperative complications, and hospital stay were recorded. All patients were followed up at outpatient clinic after 3 months, 6 months, and 12 months for clinical evaluation using Visual Analogue Scale (VAS) of leg pain and Oswestry Disability Index (ODI), and radiological assessment was performed using dynamic views plain X-ray of lumbosacral spine to detect postoperative instability.

Statistical Analysis

Student's unpaired *t*-test, Chi-squared test, and Fisher's test were used to compare the results of both groups.

RESULTS

This study included 30 patients with lumbar canal stenosis. Twelve patients were males and 18 were females. The mean age was 52.5±6.62 (range, 40–60) years in Group A and 52.2±7.24 (range, 40–65) years in Group B. Demographic data of our study are summarized in Table 1. The mean operative time was 73.5±14.54 minutes in Group A and 85.5±17.07 minutes in Group B. The mean blood loss was 127±37.43 ml in Group A and 152±50.95 ml in Group B. The mean hospital stay was 1.8±0.42 days in Group A and 2.4±0.7 days in Group B. There was no statistically significant difference between the two groups in regard to the operative time, blood loss, and hospital stay as shown in Table 2. Dural tear has been reported in 1 patient (6.7%) in Group A and in 2 patients (13.3%) in Group B. Unintended intraoperative durotomy in all patients was repaired directly by simple suturing and fibrin glue and there was no postoperative CSF leak. No cases of postoperative wound infection or dehiscence were reported in both groups. Operative clinical outcomes are summarized in Table 3 and Figures 3 and 4. The mean preoperative VAS has been markedly improved from 8.7±0.95 to 1.9±0.99 in Group A and from 8.6±0.84 to 1.8±0.99 in Group B at 1-year follow-up. Also, preoperative ODI has been improved from 30.9±5.95 to 11.3±3.30 in Group A and from 33.9±9.02 to 13.1±4.58 in Group B at 1-year follow-up. No postoperative instability was detected in any of our patients after 1 year.

Table 1. Summary of patients' data in both groups.

Parameters	Group A	Group B	P-value
Sex (male:female)	7:8	5:10	0.160
Age	52.5±6.62 (40-60)	52.2±7.24 (40-65)	0.524
Clinical manifestation			
Radicular pain Claudication	6 (40%) 9 (60%)	4 (26.7%) 11 (73.3%)	0.178
Number of stenosis levels			
1 level 2 levels	12 (80%) 3 (20%)	14 (93.3%) 1 (6.7%)	0.655
Level of stenosis:			
L3.4 L4.5 L3.4 + L4.5 L4.5 + L5.S1	3 (20%) 9 (60%) 2 (13.3%) 1 (6.7%)	3 (20%) 11 (73.3%) 1 (6.7%) 0	0.392

Table 2. Operative clinical outcome parameters.

Parameters	Group A	Group (B)	P-value
Operative time (min)	73.5±14.54	85.5±17.07	0.108
Blood loss (cc)	127±37.43	152±50.95	0.227
Hospital stay (days)	1.8±0.42	2.4±0.7	0.032
Intra operative dural tear	1 (6.7%)	2 (13.3%)	0.531
Postoperative complication	0%	0%	

Table 3. VAS and ODI scores after 1-year follow-up

Parameters		Group A	Group B	P-value
VAS	Preoperative Postoperative	8.7±0.95 1.9±0.99	8.6±0.84 1.8±0.99	P=0.806 P=1.000
		*P1<0.001	*P1<0.001	
ODI	Preoperative Postoperative	30.9±5.95 11.3±3.30	33.9±9.02 13.1±4.58	P=0.392 P=0.327
		*P1<0.001	*P1<0.001	

P= P value comparing both groups.

*P1= P value comparing pre- and postoperative of the same group.

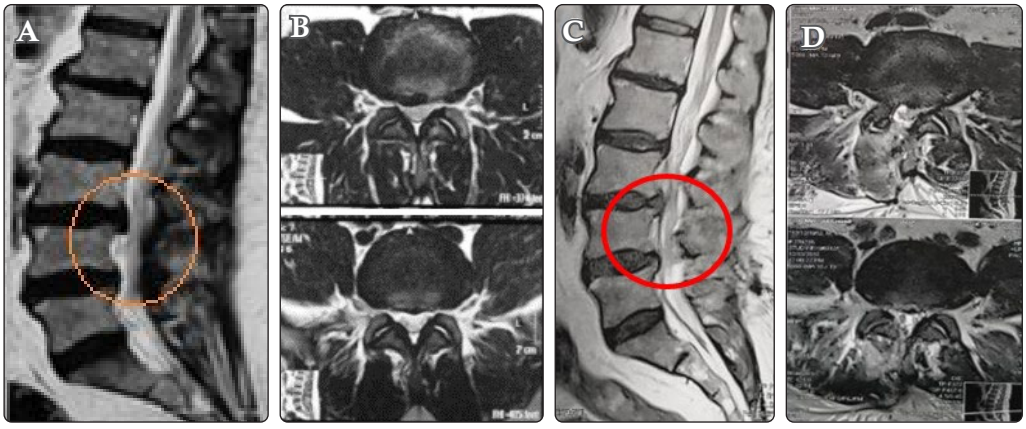

Figure 1. A case of L3-L4 and L4-L5 stenosis undergoing laminotomy. (A) Preoperative MRI sagittal view. (B) Preoperative MRI axial view. (C) Postoperative MRI sagittal view. (D) Postoperative MRI axial view.

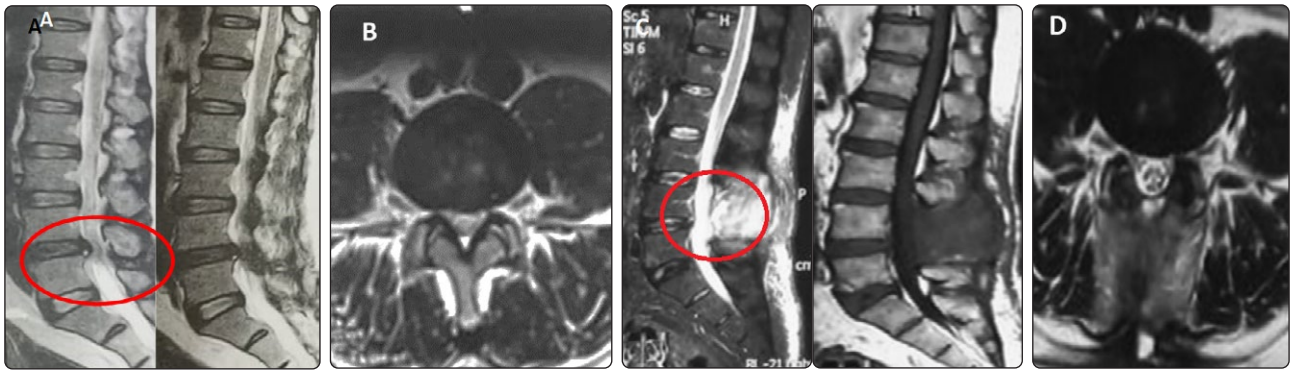

Figure 2. A case of L4-L5 stenosis undergoing laminectomy. (A) Preoperative MRI sagittal view. (B) Preoperative MRI axial view. (C) Postoperative MRI sagittal view. (D) Postoperative MRI axial view.

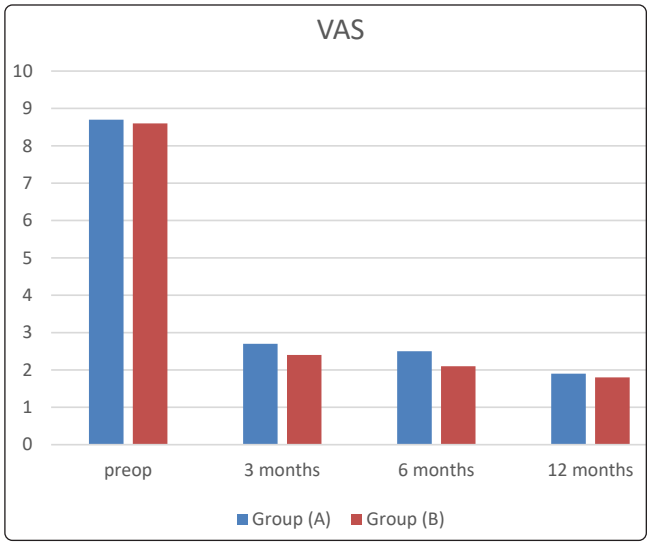

Figure 3. VAS of leg pain in both groups through one-year follow-up

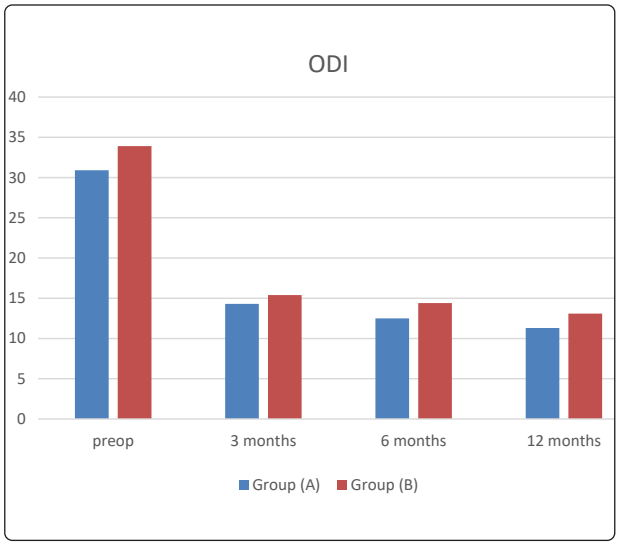

Figure 4. ODI of both groups through one-year follow-up

DISCUSSION

Lumbar canal stenosis is considered a common problem in elderly patients. Nonoperative therapies include analgesics, non-steroidal anti-inflammatory medication, epidural steroid injections, and physical therapy. If failure of conservative management occurs, surgery should be considered. Several surgical techniques have been described over the last decades. Traditional conventional laminectomy and undercutting medial facetectomy with foraminotomy were the gold standard for the treatment of lumbar canal stenosis. The overall success rate ranges from 62 to 70 %, with surgical failures being attributed to local tissue trauma and postoperative spinal instability.[3]

Wide retraction and bilateral stripping of the multifidus muscle tether the medical branch of the dorsal ramus, with increasing risk of muscle denervation. This was associated with significant chronic postoperative pain, prolonged hospitalization, delayed recovery period, and poor quality of life.[12]

Loss of midline spinous process and supraspinous and interspinous ligaments led to change in the segmental motion during flexion. Therefore, spinal instability occurs with chronic pain syndrome and poor outcome.[10]

Mullin et al.[6] long term follow-up found out that there is 54% of spinal instability on dynamic radiograms after wide decompressive laminectomy.

The advantage of minimally invasive procedures is in reduction of soft tissue trauma; however, they are still not widely performed. Unilateral laminotomy for decompression is the most used technique nowadays. Although many clinical studies reported good results, the number of the randomized comparative studies between wide conventional laminectomy and unilateral laminotomy is insufficient.[5]

The unilateral approach was described by Young et al. and modified by McCulloch in 1988. They found a good outcome of 90.9% in their study.[14]

Thome et al.[11] reported similar clinical improvement after unilateral laminotomy equal to open conventional laminectomy during a period of 1-year follow-up.

The mean age of the patients in our study was nearly 52 years for both groups. This agreed with Kalichman et al.[4] which included 191 patients with mean age of 52.6 years. In the series of Cavusoglu et al.[3] and Ng et al.[7], the mean ages were 69 years and 62 years, respectively. The younger mean age group may be due to the fact that our patients suffered from ligamentous stenosis rather than bony stenosis, which was more frequent in older age group because of degenerative changes occurring.

Female predominance was noticed in our series and this agreed with Abbas et al.[1] study which included 13 females and 8 males. In Thaker et al.[10] study on 40 patients, male predominance was shown; this was attributed to heavy outdoor duties done by males. While Kalichmen et al.[4] included 191 patients no significant difference was observed in distribution between the two sexes.

In our study, the operative time for both groups ranged between 60 and 120 minutes, but the mean in Group A was 73 minutes while, in Group B, it was 85 minutes. Additionally, Usman et al.[12] and Shabat et al.[9] showed that their mean operative time was 69 minutes for unilateral laminotomy and 79 minutes for conventional laminectomy.

Our intraoperative blood loss ranged between 100 and 250 cc for both groups. The mean for unilateral laminotomy Group A and the conventional laminectomy Group B was 127 cc and 152 cc, respectively. None of the patients required blood transfusion in both groups. The amount of blood loss was lesser for unilateral laminotomy group than conventional laminectomy group; however, it was statistically insignificant. These results coincide with Yaman et al.[13] results, who had mean average bleeding of 90 cc in unilateral approach and 238 cc in conventional laminectomy.

Regarding intraoperative complications, we reported that one patient (6.7%) had unintended dural tear in the unilateral approach (Group A),

while two patients (13.3%) had unintended dural tear in the conventional laminectomy (Group B). All dural tears were small and directly repaired by simple suturing and fibrin glue. The difference between complication rates in both groups was not statistically significant. Podichetty et al.[8] found that 4.5% of their patients had unintended durotomy, while Cavusoglu et al.[3] and Ng et al.[7] stated that dural tear occurred in a range of 5–15% of their patients. Postoperative CSF leak, wound infection, or wound dehiscence did not occur in our study during the period of follow-up.

The main duration of hospital stay in patients receiving unilateral approach was 1.8 days, while it was 2.4 days in conventional laminectomy patients. We thought that unilateral approach with preserved bony structure, ligaments, and muscles on the other side intact led to early mobilization and patient satisfaction. Our results were compatible with other series[10,13] that reported a range of 1.2–4 days in unilateral approach and 2–7 days for conventional laminectomy.

Lumbar canal stenosis usually occurs slowly over years. The disc height is lost with aging and this causes bulging of the disc into the spinal canal. Bone spurs, thickened ligaments, and hypertrophied facets contribute to narrowing of the spinal canal and compression of the nerve roots.

All these factors lead to the symptoms of low back pain and leg pain. In our study, the symptoms of the patients were assessed by the Visual Analogue Scale (VAS). We found a significant reduction between the preoperative VAS score (mean 8.7 in Group A; 8.6 in Group B) and postoperative VAS score (mean 1.9 in Group A 1.8 in Group B) for both groups, with a statistically significant difference (P1<0.001) in each group as shown in Table 3. But, there was a statistically insignificant difference when comparing the preparative VAS and the 12-month postoperative VAS in the two groups (P-value =1). In addition, Yaman et al.[13] and Abbas et al.[1] found insignificant difference in the VAS score when comparing the two groups.

In addition to the Visual Analogue Scale, we also evaluated the clinical outcome after surgery using the Oswestry Disability Index (ODI). There was a good result in the two groups. However, there were statistically insignificant differences when comparing the two groups to each other (P=0.327) and this was agreement with the results of Abouelmatty et al.[2]

The marked improvement in VAS and ODI indicated that unilateral laminotomy approach for bilateral decompression of lumbar canal stenosis was an efficient technique in treating lumbar canal stenosis. All patients were followed up using X-rays after 1 year and no slippage occurred postoperatively. Other studies showed higher rate of slippage and this was due to the long-term follow-up compared to our series.

The limitations of this study were the relatively small number of patients and short-term follow-up period. Increasing the sample size and the follow-up period is recommended in future studies.

CONCLUSION

The unilateral laminotomy approach used for bilateral neural decompression is an effective technique for treatment of lumbar canal stenosis in comparison to conventional laminectomy approach. This approach may decrease postoperative pain and disability as well as hospital stay and thereby treatment costs.

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الملخص العربي

دراسة لمقارنة المنهج الجراحي أحادي الجانب لشق الصفيحة والمنهج الجراحي التقليدي لاستئصال الصفيحة لحالات ضيق القناة القطنية.

البيانات الخلفية: ضيق القناة القطنية شائع في مرضى السمنة والمسنين. بعد أن أثبتت جميع خيارات العلاج التحفظي عدم نجاحها, يجب النظر في التدخل الجراحي. قد كان استئصال الصفيحة القطنية بالكامل هو المعيار الذهبي للعلاج الجراحي, ولكن وجدت مضاعفات على المدى الطويل. ولهذا في الآونة الأخيرة برزت جراحات التدخل المحدود كأحد الأساليب البديلة.

الغرض: المقارنة بين نهج قطع الصفيحة أحادي الجانب ونهج استئصال الصفيحة القطنية بالكامل لعلاج حالات ضيق القناة القطنية, فيما يتعلق بالنتائج الجراحية والسريرية.

تصميم الدراسة: هذه دراسة مستقبلية, اشتملت على 30 مريضاً يعانون من ضيق القناة القطنية. حيث أجريت الدراسة بقسم جراحة المخ والأعصاب كلية الطب جامعة أسيوط, وتم تقسيمهم عشوائياً إلى مجموعتين. خضع 15 مرضى لنهج قطع الصفيحة أحادي الجانب (مجموعة أ), في حين خضع 15 مرضى آخرين لنهج استئصال الصفيحة بالكامل (مجموعة ب).

المرضى والطرق: تم أخذ التاريخ المرضى والتقييم الإكلينيكي للمرضى, وتم عمل أشعات عادية ورنين مغناطيسي لكل المرضى قبل إجراء الجراحة. تم تسجيل وقت الجراحة ونسبة فقدان الدم والإقامة بالمستشفى. وأيضاً تم تقييم النتائج السريرية قبل وبعد الجراحة باستخدام قيم الألم الكلى ومؤشر قيم أوزويسترى للعجز. وتمت متابعة المرضى لمدة عام بعد التدخل الجراحي.

النتائج: كان متوسط عمر كلتا المجموعتين حوالي 52 عاماً وكان أكثرهم من الإناث. كان متوسط وقت الجراحة 73 دقيقة في المجموعة (أ) و85 دقيقة في المجموعة (ب). تم تسجيل فقدان دم أقل مع المجموعة (أ) من المجموعة (ب). أصيب 3 مرضى بقطع غير مقصود للأم الجافية في كلتا المجموعتين ولم يحدث تسريب سائل نخاعي في أي من الحالات. تم تحقيق انخفاض ملحوظ في متوسط قيم الألم الكلى وقيم أوزويسترى لمؤشر العجز في كلتا المجموعتين دون فرق ذي دلالة إحصائية.

الاستنتاج: نهج استئصال الصفيحة أحادي الجانب المستخدم لتخفيف الضغط العصبي ثنائي الجانب هو تقنية فعالة لعلاج حالات ضيق القناة القطنية بالمقارنة بنهج استئصال الصفيحة التقليدي.