Clinical Article

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

Egy Spine J 27:29-37, 2018

www.esa.org.eg

Efficacy of Endoscopic Surgery in Management of Patients with Lumbar Canal Stenosis

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Submitted:
January 2nd, 2018
Accepted:
January 30th, 2018

Abstract

Background Data: The treatment of lumbar stenosis has originally included extensive resections of posterior neural arch components. Moreover, wide muscular dissection and retraction is generally used to accomplish sufficient visualization. With the advancing noninvasive neuro-imaging modalities; the major component of neurological pressure typically occurs at the level of the interlaminar window. Microendoscopic decompressive laminotomies (MEDL) have now increased popularity among spine specialists for the treatment of lumbar canal stenosis. It has been developed from the unilateral hemilaminotomy technique.

Purpose: To evaluate the efficacy of lumbar endoscopic decompression in patients of segmental lumbar canal stenosis from a unilateral skin incision.

Study Design: A prospective clinical case study.

Patients and Methods: A total of 30 patients 10 males and 20 females were operated in Alexandria Main University Hospital, during the period from January 2013 to June 2015. The degree of pain and disability were assessed pre-operatively using the Visual Analogue Scale (VAS), both for radicular pain and back pain (if present), and the Oswestry Disability Index (ODI). The length of the incision, the duration of surgery, the operative blood loss, and duration of hospital stay were calculated. Mean follow up period for patients was 38.5±18.2 months (Range, 36-48).

Results: The mean age was 62.7±6.9 years. All patients had claudicating sciatica; 57% had bilateral sciatica, while 43 % had unilateral sciatica. 60% had low back pain. Only 3 patients (10%) had motor weakness preoperatively. 24 patients (80%) had single level affection, while 6 patients (20%) had double level affection. We operated totally on 36 segmental levels. There was a statistically significant reduction for the mean values of VAS both for radicular pain and back pain in the follow up period ($P<0.001$). Also, there was a statistically significant reduction for the ODI mean value in the follow up period ($P<0.001$). Operative blood loss was 109.5±63.2 ML. Mean operative time was 103.8±32.7 minutes. Mean duration of hospital stay was 1.5±0.6 days (Range, 1-3 days). We had two patients of intraoperative dural tears (7%) with no postoperative CSF leak occurred, two patients (7%) had superficial wound infection, no patients had deep wound infection or discitis, and no patients encountered of postoperative instability in the follow up period.

Conclusion: Endoscopic surgery for bilateral decompression through a unilateral approach is a useful and effective procedure for treating patients with lumbar canal stenosis with encouraging results. (2018ESJ161)
Keywords: Endoscopic surgery; lumbar canal stenosis; endoscopic laminotomy

Introduction

Lumbar canal stenosis is one of the commonest illnesses of the geriatric population. For patients beyond 65 years old, it is among the main reasons for spinal surgery.[16] The pathophysiology of lumbar canal stenosis is complex, and neural compression occurs due to a combination of degenerative changes; namely ligamentum flavum hypertrophy, intervertebral disc protrusions, and facet arthropathy.[14,26,29]

Treatment of lumbar canal stenosis has originally included extensive resections of posterior neural arch components. Moreover, wide muscular dissection and retraction is generally used to accomplish sufficient visualization. The operations of wide decompressive laminectomy, medial facetectomy, and foraminotomy have been utilized for quite a long time with variable degrees of success.[1,16] Loss of the midline supraspinous–interspinous ligamentous complex adds to lost flexion stability, jeopardizing postoperative spinal stability.[27] Extensive laminectomy can likewise be related with critical operative blood loss, and additionally delayed postoperative recovery and weakness of back muscles due to the muscular detachment, which may explain the increased risk of occurrence of "failed back syndrome" and chronic pain.[21]

Knowing more about the pathoanatomy of lumbar stenosis with the advancing noninvasive neuro-imaging modalities; the major component of neurological pressure typically occurs at the level of the interlaminar window.[22] Many surgeons have thus used multilevel focal laminotomy as an alternate option to wide laminectomy.[1,14] Such laminotomies attempt additionally to preserve the midline bony and ligamentous complex, taking into account enhanced postoperative muscle attachment and preserving its function. This pattern toward diminished iatrogenic tissue injury was conveyed in 1988 by Young et al,[32] who announced a one-sided hemilaminotomy method. This technique was described by one-sided multifidus dissection, ipsilateral decompression, and furthermore contralateral decompression performed under the midline bony and ligamentous structures, using the microscope. This technique has been modified further and utilized effectively by various surgeons.[2,21,22,32]

Along a similar line of change and diminishing iatrogenic tissue injury, microendoscopically assisted laminotomies have now increased popularity among spine specialists for the treatment of lumbar canal stenosis. It has been especially encouraging for its small skin incision, delicate tissue manipulation, brilliant visualization, and ability to give good results, comparable to open procedures. The microendoscopic decompressive laminotomy (MEDL) method is another, less invasive surgical modality, developed from the unilateral hemilaminotomy approach.[8,1113,17]

This study aims to evaluate the efficacy of bilateral lumbar endoscopic decompression in patients of segmental lumbar canal stenosis from a unilateral skin incision. The results, complications and applicability to various segments in lumbar surgery at different levels; will be evaluated.

Patients and Methods

This is a prospective clinical case study that included thirty patients with lumbar canal stenosis. All patients were operated in Alexandria Main University Hospital, during the period from January 2013 to June 2015. Clinically, patients had claudicating lower limb radiculopathy (unilateral or bilateral), sometimes associated with low back pain, and consistent with a radiologically demonstrated lumber canal stenosis, with either single or double level affection. Patients with pure sensory radiculopathy had failed conservative treatment for at least 8 weeks, whereas those with motor weakness underwent earlier surgery. The exclusion criteria included: Spondylolisthesis, cauda equina syndrome, more than two-level lumbar stenosis, or the presence of an associated pathology such as acute inflammation, tumor, discitis or other infections.

The degree of pain and disability were assessed pre-operatively using the Visual Analogue Scale (VAS), both for radicular pain and back pain (if present) and the Oswestry Disability Index (ODI). All patients were operated with Destandau mobile endoscopic system (Endospine, Karl Storz, Tuttlingen, Germany). The length of the incision, the duration of surgery, the mean operative blood loss, and duration of hospital stay were calculated. Mean follow up period for patients was 38.5±18.2 months (Range, 36-48). Follow up assessment included clinical evaluation using VAS and ODI, dynamic X-rays, CT and/or MRI were only done when clinically indicated.

Surgical Technique: (Figure 1)

Using the endoscopic system (Endospine, Karl Storz, Tuttlingen, Germany), the skin incision is made one finger breadth, on the more symptomatic side. Part of the superior lamina and the medial part of the articular mass are resected to expose the lateral limit of the dural sheath; a high speed burr is used. The lateral expansion of the yellow ligament and part of the articular mass are resected downwards to decompress the ipsilateral nerve root. After sufficient decompression has been achieved ipsilaterally, two cottonwoods are inserted under the base of the spinous process in both cephalic and caudal directions to protect the dural theca. Then the fundus of the spinous process is resected with a Kerrison rongeur or high-speed burr, and a working space is made between the dural theca and the contralateral lamina (crossing over the top technique). Meanwhile, the operating tube is tilted to the opposite side, exposing the contralateral canal clearly under endoscopic vision. Then the contralateral ligament flavum and the inferior part of proximal lamina are undercut with a Kerrison rongeur until the contralateral nerve root is released. Bleeding from the venous plexus is controlled by bipolar coagulation.

Results

This study included 30 patients with lumber canal stenosis; 20 females67%)) and 10 males (33%). The mean age was 62.7±6.9 years (48-71 years). All patients had claudicating sciatica; 17 patients (57%) had bilateral sciatica, and 13 patients (43 %) had unilateral sciatica. 18 patients (60%) had low back pain. Only 3 patients (10%) had motor weakness preoperatively. 24 patients (80%) had single level affection, while 6 patients (20%) had double level affection with total 36 levels operated upon. The most commonly affected level was L4-5 (60%), followed by L3-4 (34%), and L2-3 (6%) (Table 1).

Preoperative VAS for radicular pain mean value was 8.3±0.6, and there was a statistically significant reduction for its mean value in the follow up periods ($P<0.001$). At 2 weeks the mean VAS was 2.0±0.6, 1.6±0.5 at 6 months, 1.4±0.5 at 1 year, and 1.4±0.5 at 3 years follow up. Preoperative VAS for back pain mean value was 8.0±1.0, and again there was a statistically significant reduction for its mean value in the follow up periods ($P<0.001$). At 2 weeks the mean VAS was 2.0±0.5, 1.6±0.5 at 6 months, 1.4±0.5 at 1 year, and 1.6±0.6 at 3 years follow up. Preoperative ODI mean value was 71.7±6.5, and there was a statistically significant reduction for its mean value in the follow up periods ($P<0.001$). At 2 weeks its mean value was 19.9±4.1, 18.3±3.4 at 6 months, 15.5±3.6 at 1 year, and 13.8±3.1 at 3 years follow up. (Table 2) (Figure 2,3)

The mean operative blood loss was 109.5±63.2 ML (Range, 50-300). The mean operative time was 103.8±32.7 minutes (Range, 70-180).The mean duration of hospital stay was 1.5±0.6 days (Range, 1-3). The length of skin incision was 2 cm in all patients (this value was constant because it represents the diameter of the working piece of the endoscope). (Table 1)

Reported complications in this study was as follow; two patients of dural tears (7%); both were repaired intraoperatively using muscle graft and fibrin glue with no postoperative CSF leak occurred, two patients (7%) had superficial wound infection, no patients had deep wound infection or discitis, and none encountered postoperative instability in the follow up period. (Table 1) (Figure 4,5). There was no conversion to an open procedure in any of our patients.

Table 1. Descriptive Data Studied Patients in this Study

Parameters		No. (%)
Sex	Male	10 (33.3%)
	Female	20 (66.7%)
Age		62.7±6.9 (48–71.0)
Back pain		18 (60%)
Sciatica	Right	7 (23.3%)
	Left	6 (20%)
	Bilateral	17 (56.7%)
Level	Single	24 (80%)
	Double	6 (20%)
Operative blood loss/ML		109.5±63.2(50-300)
Duration hospital stay/days		1.5±0.6(1 – 3)
Operative time/minutes		103.8±32.7(70–180)
Complications	Dural tear	2(6.7%)
	Superficial wound infection	2(6.7%)

Table 2. Clinical Outcome According to VAS and ODI

Parameters	Preoperative	Post-operative				P
		2 Weeks	6 Months	1 Year	3 Years	
Root pain/VAS	8.3±0.6(7–10)	2.0±0.6(1–3)	1.6±0.5(1–2)	1.4±0.5(1–2)	1.4±0.5(1–3)	<0.001*
Back pain/VAS	8.0±1.0(6–10)	2.0±0.5(1–3)	1.6±0.5(1–2)	1.4±0.5(1–2)	1.6±0.6(1–3)	<0.001*
ODI	71.7±6.5(60–82)	19.9±4.1(14-30)	18.3±3.4(14-28)	15.5±3.6(10–24)	13.8±3.1(10–22)	<0.001*

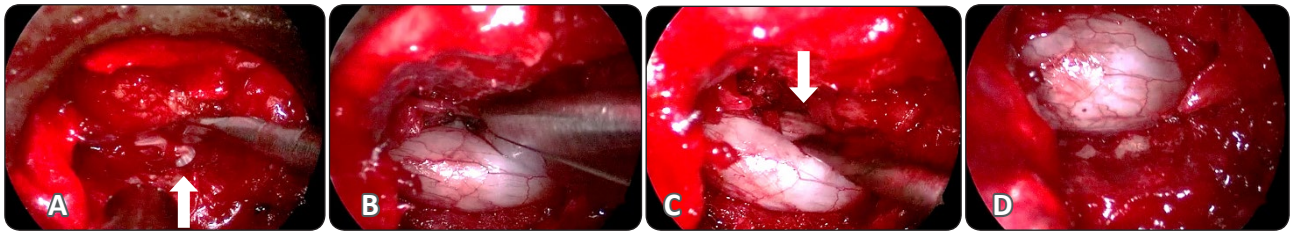

Figure. 1 (A) Endoscopic view showing the ipsilateral nerve root (white arrow) after resection of part of the superior lamina and the medial part of the articular mass. (B) Endoscopic view after sufficient ipsilateral decompression and after the fundus of the spinous process was resected (crossing over the top technique) exposing contralateral nerve root. (C) Endoscopic view, showing the contralateral nerve root adequately decompressed (white arrow). (D) Final endoscopic view after decompression has been completed on both sides, from a unilateral skin incision.

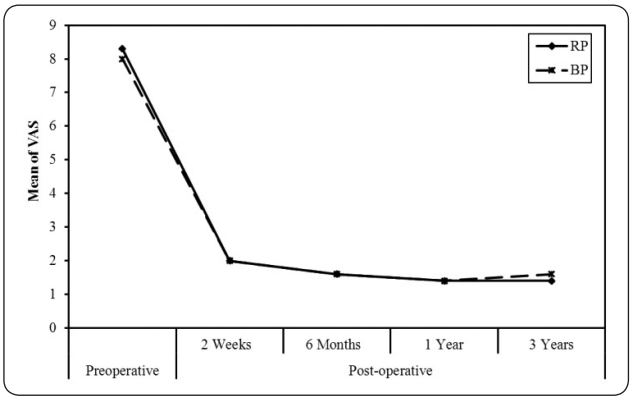

Figure 2. Reported VAS for both back (BP) and root pain (RP) through the period of follow up.

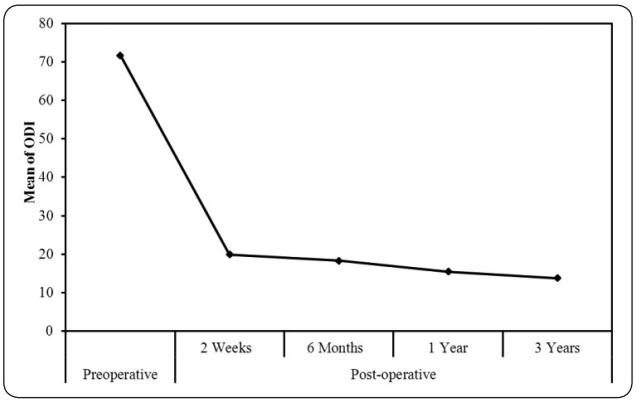

Figure 3. Reported ODI through the period of follow up.

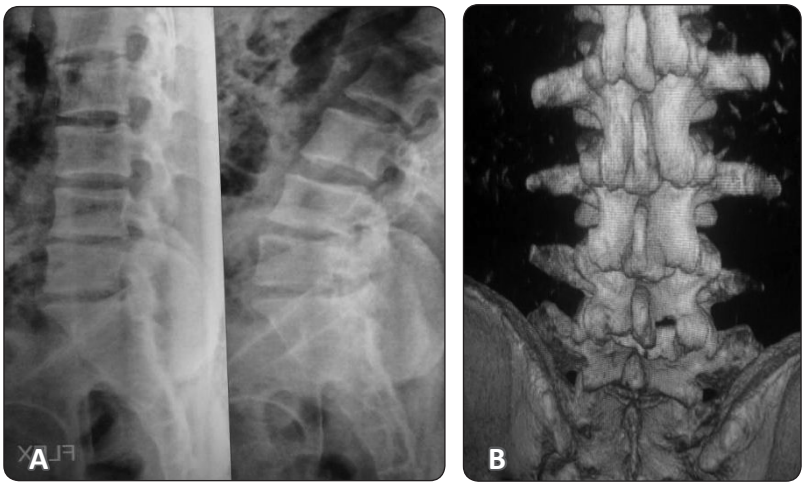

Figure 4. (A) Plain Radiographs (dynamic lateral view), 2 years postoperative, showing sound dynamic stability. (B) 3D CT bone window reconstruction, showing extent of bone removal.

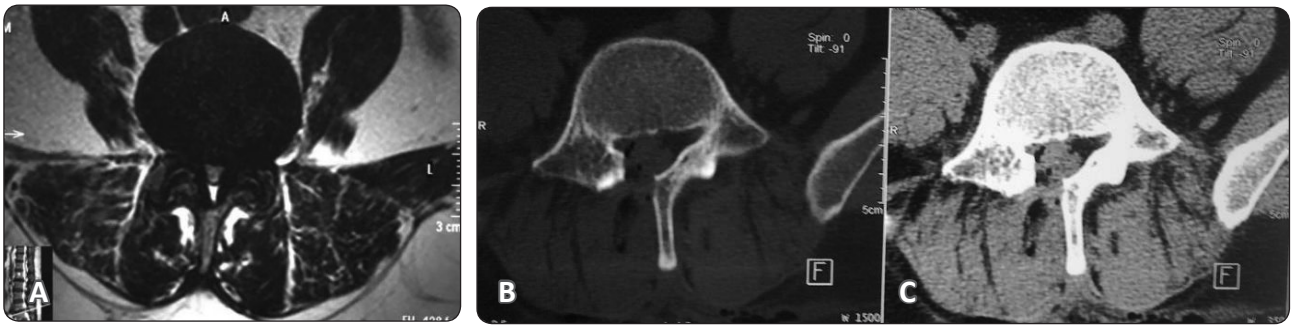

Figure 5. (A) Preoperative MRI, Axial T2 section, showing L4-5 stenosis. Postoperative CT, Axial sections, (B) bone window & (C) soft tissue window, showing extent of fenestration done from one side & decompression of nerve roots on both sides.

Discussion

Classically the treatment of lumbar spinal stenosis involved extensive laminectomy and undercutting of the medial facet with foraminotomy. The surgical failures of this technique have been attributed to musculo-ligamentous trauma and postoperative spinal instability.[5,11] Many surgical modalities for lumbar canal decompression have been described, aiming to relieve the symptoms of the patient, and preserving the anatomy while keeping stable biomechanical function of the lumbar spine as much as possible. Minimally invasive techniques as unilateral approach for bilateral neural decompression have been employed to decompress the spinal canal.[2,7] Endoscopic decompressive laminotomy is an attractive alternate because of its minimally invasive nature.[11,23]

Evaluation of modern minimally invasive techniques needs long term follow up. In the current study we performed endoscopic laminotomy to unilaterally decompress bilaterally spinal canal and neural foramina, and followed the patients for a mean of 38.5±18.2 months (Range, 36-48). The VAS scores both for radicular and low back pain showed statistically significant improvement, and this improvement was consistent all over the 3 years follow up period. Also the ODI scores showed statistically significant improvement, and again were consistent over the period of follow up (3 years). That was similar to the results of Pao et al,[23] who had significant improvement in ODI and JOA (Japanese Orthopedic Association) scores in their series, with mean follow up period of 16 months (Range, 12-24). Also Khoo and Fessler,[13] reported similar improvement with VAS, both for radicular and back pain. In Kabil and Ebrahim series,[12] there was a significant improvement of back pain in 77.9% of patients and in radiating leg pain in 86.3%. With regards to functional outcomes, median preoperative JOA score was 14.93±0.48 and improved postoperatively to 27.17±1.45 (P<0.001).

Endoscopic surgery carries many challenges for surgeons, the most critical of which is mastering hand-eye coordination. Three dimensional pictures are seen on a video screen, in a two dimensional design; this creates deficient perception of depth. This is why endoscopic surgery has a steep learning curve to accomplish competency.[9,24] A few parameters have been utilized to evaluate the learning curve and adapt for medical procedure; surgical time is by all accounts the most important measure.[18] This measure combines various subjective factors, for example, surgeon comfort, speed and intentionality of movements, familiarity with the endoscope and with the surgical procedure, and simplicity of dissection and anatomic exposure. In our study, the mean operative time was 103.8±32.7 minutes (Range, 70-180). In Nomura et al,[18] the mean operating time per level was 66.1 minutes (Range, 23-165), and in Kabil et al,[12] the mean operating time per level was 78 minutes. The lower mean time in both series might be attributed to the higher number of levels operated (753, 707 levels respectively) and the more experience of the surgeon.

Other objective measures have included complications rate,[18,25] blood loss[25], length of hospitalization,[6,15,18] and conversion to an open procedure.[10,15,18] In our study, the procedure was well tolerated, with minimal operative and postoperative (immediate and late) complications. Only two patients of dural tears (7%); both were repaired intraoperatively using muscle graft and fibrin glue. No postoperative CSF leak occurred. Two patients (7%) had superficial wound infection, but no patients had deep wound infection or discitis. No patients encountered postoperative instability in the follow up period (3 years). In the study of Pao et al,[23] five patients had dural tears (8%). In Nomura et al,[18] nine patients (2%) involved dural tears, all of which were pinholes and were repaired with a patch technique without open conversion. In Kabil et al,[12] dural tears occurred in 27 (4.6%) patients; and they were successfully repaired intraoperatively with no consequent CSF leakage.

In our series, operative blood loss mean was 109.5±63.2 ML (Range 50-300). In Kabil et al,[12] on level analysis, the mean operative blood loss was 18.6 ML which is less than our result and less than numbers previously published in the literature (Range between 25 and 150 ML) by Asgarzadie and Khoo[3] and Xu et al,[30] respectively. The mean duration of hospital stay was 1.5±0.6 days. That was similar to most of reported studies with mean hospitalization

days following the procedure was 1.4 days.[4,31] There was no conversion to an open procedure in any of our patients. This matches well with Khoo and Fessler,[13] who compared microendoscopic decompressive laminotomy with open decompression in patients with lumbar canal stenosis and concluded that the endoscopic procedure had reduced blood loss, shortened postoperative hospital stay, and diminished use of narcotics.

The importance of understanding the learning curve for new minimal-access surgery procedures for the spine lies in its implications for surgical behavior and training, patient care, and assessment of the efficacy of the procedure.[10,19]

Conclusion

Endoscopic surgery for bilateral decompression through a unilateral approach is a useful and effective procedure for treating patients with lumbar canal stenosis with encouraging results.

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The authors report no conflict of interest

الملخص العربي

فاعلية المنظار الجراحي في علاج مرضي ضيق القناة العصبية للفقرات القطنيه

البيانات الخلفية: تعتبر جراحة منظار العمود الفقري إجراءً جديدًا نسبيًا يوفر الوصول إلى الحد الأدنى من الضاعفات. تستخدم جراحة منظار العمود الفقري لمعالجة ضيق القناة القطنية الآن بشكل شائع من قبل جراحي العمود الفقري مع نتائج جيدة.

الغرض: تم إجراء هذه الدراسة لتقييم مدى فائدة وفعالية الجراحة بالمنظار في علاج المرضى الذين يعانون من ضيق القناة القطنية عن طريق شق أحادي لتوسيع القناة القطنية علي الجانبين.

تصميم الدراسه: دراسة مستقبلية، اشتملت 30 مريضا تم تشخيصهم بضيق القناة القطنية بقسم جراحة المخ والأعصاب؛ كلية الطب، جامعة الإسكندرية.

المرضي و الطرق: تم اختيار جميع المرضى من قسم جراحة المخ والأعصاب؛ كلية الطب؛ جامعة الإسكندرية على مدى فترة ثلاث سنوات من يناير 2013 إلى يونية 2015. تم علاج 24 مريضا في مستوى واحد، في حين عولج 6 مرضي في مستوين. تم تقييم جميع المرضى بعد اسبوعين من العملية الجراحية و بعد 6 اشهر, و سنة و 3 سنوات . تم استخدام مقياس التماثلية البصرية (VAS) لقياس شدة الألم في الساقو الظهر و مؤشر العجز Oswestry (ODI) لتقييم النتائج الوظيفية. بالإضافة إلى ذلك تم تقييم الوقت الجراحي وفقدان الدم ومعدل المضاعفات والإقامة في المستشفى. كان متوسط فترة المتابعة 38.5 شهرًا.

النتائج: كانت هناك 20 أنثى و 10 من الذكور، بمتوسط عمري 62.7 سنة.كان متوسط مدة الجراحة 90 دقيقة وكان متوسط فقدان الدم أثناء العمليات 109 سم مكعب. كانت متوسط مدة الإقامة في المستشفى يوم ونصف. وشملت مضاعفات أثناء العملية حالتين قطع للأم الجافية و تم اصلاح القطع عن طريق وضع قطعة من العضلة و صمغ طبي . وشملت مضاعفات ما بعد الجراحة حالتين عدوى الجرح السطحي، و لم تكن هناك أي حالة تسرب للسائل النخاعي. كان هناك تحسن ذو دلالة إحصائية ب بين معامل مقياس التماثل البصري(VAS) قبل الجراحة و بعد الجراحة و أثناء فترة المتابعة. كذلك كان هناك تحسن ذو دلالة إحصائية بين ODI قبل الجراحة و بعد الجراحة و أثناء فترة المتابعة.

الإستنتاج: جراحة منظار العمود الفقري لمعالجة ضيق القناة القطنية خلال نهج أحادي الجانب هي إجراء مفيد وفعال لعلاج المرضى مع نتائج مشجعة. وتعمل جراحة منظار العمود الفقري علي اسراع فترة الاستشفاء بأقل معدل مضاعفات.