

# Efficacy of the Unilateral Uniportal Endoscopic Approach in Management of Monosegmental Lumbar Canal Stenosis

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## ABSTRACT

**Background Data:** Multiple surgical techniques have been used to treat spinal canal stenosis, including open, microscopic, and endoscopic decompression and fusion surgery.

**Purpose:** This article investigates the safety and the efficacy of unilateral endoscopic decompression for patients with monosegmental degenerative lumbar spinal canal stenosis (LCS).

**Study Design:** Prospective clinical case series.

**Patients and Methods:** Thirty consecutive patients with degenerative LCS were treated with endoscopic laminotomy with medial facetectomy. Patients were treated with the EasyGO!<sup>®</sup> 2nd Generation system (Karl Storz, Tuttlingen, Germany) at our institutions between March 2018 and September 2020. Primary outcomes parameters included the Numerical Pain Rating Scale (NPRS) and Oswestry Disability Index (ODI) to quantify pain and disability, respectively. The length of the incision, the duration of surgery, the operative blood loss, and the duration of hospital stay were calculated. The mean follow-up period for patients was  $10.5 \pm 2.3$  (range, 6–12) months.

**Results:** The mean age was  $56.5 \pm 5.7$  years. All thirty patients had neurogenic claudication. 63% of the patients had bilateral leg pain, 37% had unilateral leg pain, and 66% had low back pain. Seven patients (23%) had motor weakness preoperatively. The spinal segments affected were as follows: L4-L5 in 22 cases; L3-L4 in 6 cases; L2-L3, one case; L5-S1, one case. There was a statistically significant reduction in the mean values of NPRS for both leg and back pain in the follow-up period ( $P < 0.001$ ). Moreover, the ODI mean value was statistically significantly reduced in the follow-up period ( $P < 0.001$ ). the mean operative blood loss was  $147.2 \pm 68.3$  ml, the mean operative time was  $134.7 \pm 28.34$  minutes, and the mean hospital stay was  $1.4 \pm 0.8$  days. We had four patients with intraoperative dural tears (13%) with no postoperative CSF leak, three patients (10%) had superficial wound infection, no patients had deep wound infection or discitis, and no reoperation was reported in the follow-up period.

**Conclusion:** The unilateral uniportal endoscopic approach is a safe and effective technique in patients with degenerative lumbar canal stenosis. It allows for adequate decompression of the neural elements and preserves spinal stability. (2021ESJ236)

**Keywords:** endoscopic; decompression; lumbar canal stenosis; degenerative spine

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## INTRODUCTION

The main symptom of lumbar canal stenosis (LCS) is neurogenic claudication and affects mainly the old age group.<sup>34</sup> It has three main types: central, lateral recess, and foraminal.<sup>11,34</sup> The main causes are hypertrophy of the superior articular facet, ligamentum flavum, and disc herniation. The radiological extent of stenosis does not usually go hand in hand with the clinical picture; many cases are radiologically positive for stenosis but clinically asymptomatic.<sup>28,33,35</sup>

Multiple surgical techniques have been advocated for managing LCS, including microscopic and endoscopic decompression and fusion surgery.<sup>3</sup> With the evolution of endoscopic techniques for decompression of the lumbar spine, various treatment options with minimal tissue injury, lower costs comparative to fusion, and similar or better results have been developed.<sup>13, 23, 27, 32</sup> A targeted and pathology-oriented approach is the key to success to guarantee the therapeutic effect.<sup>19</sup> The most important full-endoscopic techniques are the transforaminal and interlaminar approaches.<sup>27,36,43</sup> Transforaminal endoscopic techniques have been reported to be successful in disc surgery and unilateral foraminal stenosis, but there are anatomic limitations for symptomatic bilateral lateral recess stenosis. This is more evident at the L5-S1 level, where a high iliac crest, prominent transverse process of the fifth lumbar vertebra, and a large facet joint are prevalent.<sup>15</sup> As regards the orientation and familiarity, the interlaminar endoscopic approach resembles the tubular microscopic surgical technique and are close to each other.<sup>17</sup>

All procedures of the conventional approaches can be completely substituted and fully managed endoscopically by the interlaminar surgical technique.<sup>9</sup> With advances in endoscopic techniques and instruments, earlier contraindications have become indications for full-endoscopic spinal decompression in treating lumbar degenerative diseases. Advantages of the technique are reduced

iatrogenic injury of the neural elements and preservation of the posterior vertebral column while reaching the surgical target as regard canal decompression.<sup>40</sup>

This study aimed to assess the safety and efficacy of the unilateral uniportal endoscopic approach in managing monosegmental LCS.

## PATIENTS AND METHODS

This is a prospective clinical case series that included thirty patients with LCS. All patients underwent an operation in Alexandria Main University Hospital and Kafr El-Sheikh University Hospital during the period from March 2018 to September 2020. Inclusion criteria were as follows: patients who had neurogenic claudication (unilateral or bilateral) with or without low back pain (LBP) that is consistent with a radiologically demonstrated monosegmental LCS, either bony or ligamentous, central or lateral recess of different degrees, and who failed conservative treatment for at least eight weeks. Exclusion criteria were multilevel canal stenosis, degenerative spondylolisthesis more than Meyerding Grade I, degenerative scoliosis, and prior surgery in the same segment.

All patients were submitted to clinical evaluation where the pain was assessed preoperatively using the Numerical Pain Rating Scale (NPRS) for both leg and back pain (if present), and disability was assessed using Oswestry Disability Index (ODI). All patients were assessed with preoperative MRI and dynamic standing X-ray; however, a CT scan was requested when there was a suspicion of pars defect in selected patients. All patients underwent operation using EasyGO!<sup>®</sup> 2nd Generation endoscopic system (Karl Storz, Tuttlingen, Germany). The incision length, duration of surgery, mean operative blood loss, and duration of hospital stay were calculated. The study was approved by our institutional review board. All patients gave written informed consent before the surgery. The study was conducted according to the

WMA Declaration of Helsinki–Ethical Principles for Medical Research Involving Human Subjects.

### **Surgical Technique**

Following general anesthesia, patients were placed in the prone position. After skin sterilization, a 23 mm (which is the diameter of the trocar) vertical skin incision is made nearly one and half cm off the midline, on the more symptomatic side. Under fluoroscopy, the Kirschner wire is inserted to the target point of the desired level (upper limit of the caudal lamina medial to the facet joint); the fascia is incised; then, serial dilators are docked, splitting the paraspinal muscles towards the interlaminar space. Finally, the operating sheath (trocar) is inserted, angled medially, and attached to the holder; then, the endoscopic system is inserted (Figure 1).



**Figure 1.**

The EasyGO!® 2nd Generation endoscopic system (Karl Storz, Tuttlingen, Germany) in place.

dissector exposing the contralateral canal clearly under endoscopic vision. Then, the contralateral laminotomy, in the same manner, is done. Any compressing disc material is removed (Figure 2). Epidural bleeding is controlled by gelatin sponge, oxidized cellulose, and bipolar coagulation. The incision was closed in layers with Vicryl. To prevent dural injuries, the ligamentum should be kept intact until completion of bony work and cottonoids should be inserted between the dura and the contralateral lamina during laminotomy. If this happened, postoperative bed rest in the Trendelenburg position was recommended for three days.

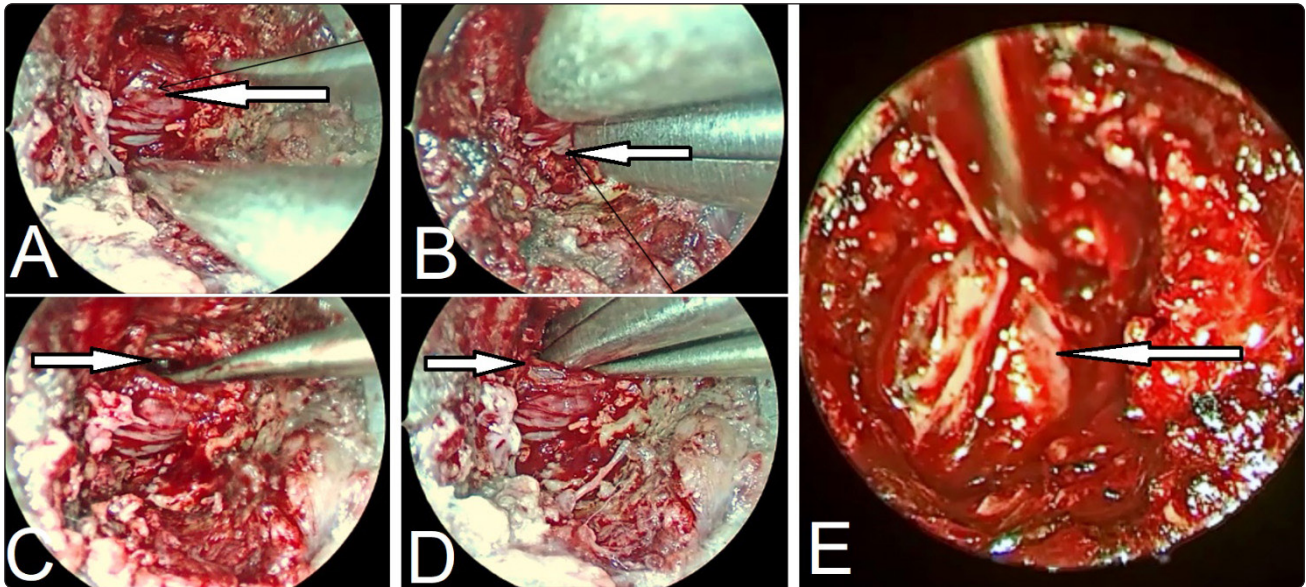
Using a high-speed drill with a diamond bur, laminotomy and partial medial facetectomy to decompress the ipsilateral traversing root in the foramen were performed using Kerrison rongeur. Then, the base of the spine process is drilled to gain access to the contralateral side. After completing bony decompression, the ligamentum flavum is removed with Kerrison rongeur and hook to expose the dural sheath centrally. The lateral expansion of the yellow ligament is removed 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 cranial and caudal directions to protect the dural sac. Moreover, a working space is made between the dural theca and contralateral lamina by the

### **Postoperative Care**

All patients had intramuscular NSAIDs for pain control upon recovery from anesthesia. Then, they were given oral NSAIDs only when needed. Intravenous third-generation cephalosporins were given at the time of anesthesia induction and continued for another two days during the hospital stay. Then, patients were given oral quinolone for five days. Patients were encouraged to increase their activities one week after the operation.

### **Follow-up:**

Patients were followed up routinely at our outpatient clinic at 2 weeks, 3 months, 6 months, and 12 months. The mean follow-up was



**Figure 2.** Operative endoscopic views showing (A) central dural exposure, (B) ipsilateral lateral recess decompression, (C,D) contralateral decompression, and (E) decompressed nerve root.

10.5  $\pm$  2.3 months (range, 6–12). The assessment included clinical evaluation using NPRS and ODI. Data were obtained from outpatient clinic follow-up visits by two independent physicians, while dynamic X-rays, CT, and/or MRI were only done when clinically indicated.

## RESULTS

This report included 30 patients with LCS, 20 females (67%) and 10 males (33%), with a mean age of 56.53  $\pm$  5.78 years (range, 45–65 years). All patients had neurogenic claudication: bilateral in 19 patients (63%) and unilateral in 11 patients (37%). Twenty patients (67%) had LBP. Only seven patients (33%) had motor weakness preoperatively. The most affected level was L4-L5 (73%), followed by L3-L4 (20%), and L2-L3, and L5-S1 (3%) for each level. Preoperative NPRS for back pain was 7.45  $\pm$  1.19; there was a statistically significant reduction to 2.0  $\pm$  0.79 at the last follow-up ( $P < 0.001$ ). The mean NPRS was 2.0  $\pm$  0.79 at 2 weeks, 1.75  $\pm$  0.44 at 3 months, 1.25  $\pm$  0.44 at 6 months, and 2.0  $\pm$  0.79 at 1-year follow-up (Table 1). Preoperative the mean NPRS leg pain was 8.43  $\pm$  1.14, and there was a

statistically significant reduction 2.0  $\pm$  0.83 at the last follow-up ( $P < 0.001$ ). The mean NPRS was 2.0  $\pm$  0.83 at 2 weeks, 1.50  $\pm$  0.51 at 3 months, 1.50  $\pm$  0.51 at 6 months, and 2.0  $\pm$  0.83 at 1-year follow-up (Table 2). Preoperative ODI mean value was 66.67  $\pm$  7.37, which significantly improved statistically postoperatively ( $P < 0.001$ ). The mean value was 19.13  $\pm$  4.62 at 2 weeks, 19  $\pm$  4.39 at 3 months, 15  $\pm$  4.39 at 6 months, and 13.4  $\pm$  3.89 at 1-year follow-up (Table 3). The mean operative blood loss was 147.2  $\pm$  68.3 (range, 60–280) ml. All patients were followed up for at least 6 months. The mean operative time was 134.7  $\pm$  28.34 (range, 80–180) minutes. The mean duration of hospital stay was 1.40  $\pm$  0.77 (range, 1–3) days. Reported complications in this study were as follows: four patients (13%) had dural tears managed operatively with no postoperative CSF leak reported and three patients (10%) had superficial wound infection managed conservatively. No patients had deep wound infection or discitis, and none encountered postoperative instability in the follow-up period. In some patients, a multislice CT scan of the lumbosacral spine has been requested to evaluate the adequacy of segmental decompression (AP diameter  $\geq$  11.5 mm) (Figure 3).

**Table 1.** Clinical outcomes according to Numerical Pain Rating Scale of back pain.

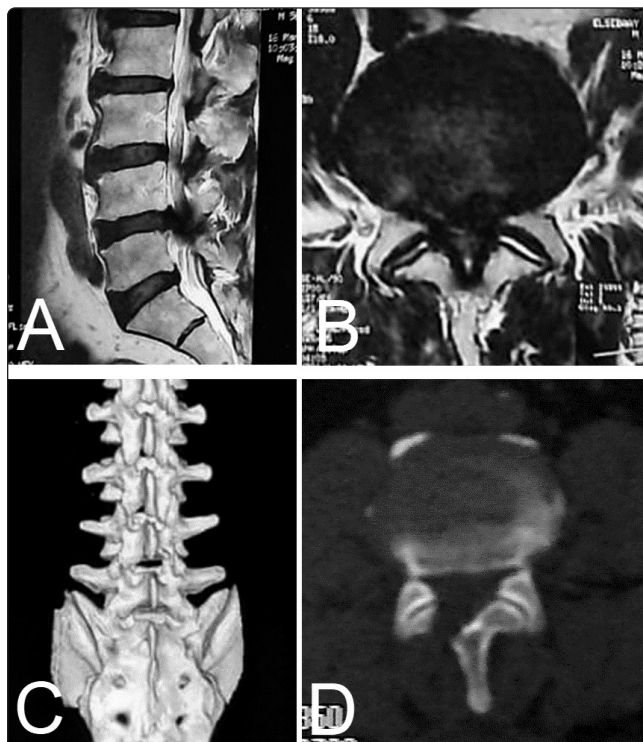
	Before	2 weeks	3 months	6 months	1 year	Fr	p
	7.45 ± 1.19 (6–9)	2.0 ± 0.79 (1–3)	1.75 ± 0.44 (1–2)	1.25 ± 0.44 (1–2)	2.0 ± 0.79 (1–3)	52.225*	< 0.001*
<b>p<sub>1</sub></b>		< 0.001*	< 0.001*	< 0.001*	< 0.001*		
<b>p<sub>2</sub></b>			0.549	0.028*	1.000		
<b>Sig. bet. periods.</b>			p <sub>3</sub> =0.110, p <sub>4</sub> =0.549, p <sub>5</sub> =0.028*				

**Table 2.** Clinical outcomes according to Numerical Pain Rating Scale of leg pain.

	Before	2 weeks	3 months	6 months	1 year	Fr	p
	8.43 ± 1.14 (7–10)	2.0 ± 0.83 (1–3)	1.50 ± 0.51 (1–2)	1.50 ± 0.51 (1–2)	2.0 ± 0.83 (1–3)	72.593*	< 0.001*
<b>p<sub>1</sub></b>		< 0.001*	< 0.001*	< 0.001*	< 0.001*		
<b>p<sub>2</sub></b>			0.102	0.102	1.000		
<b>Sig. bet. periods.</b>			p <sub>3</sub> =1.000, p <sub>4</sub> =0.102, p <sub>5</sub> =0.102				

**Table 3.** Clinical outcomes according to Oswestry Disability Index.

	Before	2 weeks	3 months	6 months	1 year	Fr	p
	66.67 ± 7.37 (56–80)	19.13 ± 4.62 (12–28)	19.0 ± 4.39 (12–26)	15.0 ± 4.39 (8–22)	13.40 ± 3.89 (8–20)	705.739*	< 0.001*
<b>p<sub>1</sub></b>		< 0.001*	< 0.001*	< 0.001*	< 0.001*		
<b>p<sub>2</sub></b>			1.000	< 0.001*	< 0.001*		
<b>Sig. bet. periods.</b>			p <sub>3</sub> =–, p <sub>4</sub> < 0.001*, p <sub>5</sub> =1.000				



**Figure 3.** Patient's images showing preoperative (A) sagittal T2 MRI, (B) axial T2 MRI showing L4-L5 lumbar canal stenosis, (C) postoperative 3D CT reconstruction showing L4-L5 segment decompression, and (D) postoperative axial image CT showing the extent of L4-L5 bony decompression.

## DISCUSSION

From the 1980s, endoscope-assisted procedures have become popular in treating different spine pathologies.<sup>1,20</sup> In 1977, Foley and Smith<sup>4</sup> first introduced the microendoscopic discectomy for lumbar disc prolapse. The indications of the microendoscopic technique were later expanded to involve the management of degenerative LCS.<sup>2</sup> In contrary to the microscopic approach, endoscopic decompression laminotomy via unilateral approach is effective in achieving satisfaction and improving the quality of life of these patients by making clinical symptoms and functional outcomes better due to higher visibility of neural structures in narrow spaces as the contralateral root.<sup>24</sup>

Thirty patients with clinically manifested LCS with neurogenic claudication were enrolled in our series. The minimally invasive nature of EDL for LCS is reflected by the lower amount of blood loss and shorter days of hospitalization compared to open laminectomy.<sup>30</sup> In our series, we performed endoscopic laminotomy to unilaterally decompress bilaterally stenotic spinal canal and neural foramina. In the current series, the mean amount of operative blood loss is like that yielded by Xu et al. (150 ml)<sup>41</sup> and larger than that presented by Khoo and Fessler<sup>14</sup> (68 ml). The mean hospitalization days following the procedure (1.4 days) matched most of those reported in EDL studies.<sup>26,42</sup> However, this duration of hospital stay was less than that reported by Khoo and Fessler<sup>14</sup> (42 hours) and Lee et al.<sup>18</sup>, whereas it was more than that presented by Rahman et al.<sup>26</sup> (18 hours). The mean operating time per level was similar to that of Xu et al.<sup>41</sup>, Pao et al.<sup>24</sup>, and Wada et al.<sup>38</sup> On the other hand, Khoo and Fessler<sup>14</sup>, Lee et al.<sup>18</sup>, Kabil et al.<sup>12</sup> reported 109 min,  $105.3 \pm 56$  min, and 78.4 min as the mean operating time per level, respectively. Contrary to published studies that reported a shorter surgery time of EDL than open laminectomy,<sup>24</sup> Yagi et al.<sup>42</sup> have reported 71.1 min as the mean operative time of EDL and

63.6 min for classic laminectomy. In Nomura et al.'s study<sup>22</sup>, the mean operating time per level was 66.1 minutes (range, 23–165). The lower mean time might be attributed to the higher number of levels operated (753) and the more experience of the surgeon. Our relatively long time may be due to the time needed to prepare the access system and EDL intrinsic technical difficulties that include 2D visualization issues, resulting in hand-eye coordination difficulty and limited working space, which needs a steep learning curve. As we became familiar (after 20 cases) with the lumbar anatomy on endoscopy, the basic usage of the endoscopic instruments, drills, and punches and total operation times were much shortened.<sup>6,29</sup>

Our outcome parameters are parallel with those of Lee et al.<sup>16</sup> ODI scores improved by 41.71 (95% CI, 39.80–43.62) after the surgery. The VAS for leg pain scores improved by 5.95 (95% CI, 5.70–6.21). The VAS for back pain scores improved by 4.22 (95% CI, 3.88–4.56). The short duration of hospital stay and the rapid return to the preoperative level of daily activities (12–14) days may be attributed to the minimally invasive nature of the endoscopic procedure. As we mentioned before, the paraspinal muscles are split and not stripped; thus, there is less muscle injury (i.e., less decrease in volume of multifidus and erector spinae muscles and less fatty degeneration) as evidenced by the postoperative MRI or CT done in some of our cases. Moreover, the midline structures (spinous process and ligaments) are preserved.

In our study, we encountered complications in 23% of the patients, intraoperatively (13.3%, dural tears) and (10%) postoperatively. In Kabil et al.'s study,<sup>12</sup> 19.55% of the patients suffered from complications, 11.1% intraoperatively and 8.4% postoperatively. The unintended durotomies were managed effectively intraoperatively with gelatin sponge, oxidized cellulose, and tight wound closure with no postoperative CSF leak. Generally, the most frequent complication in EDL studies is incidental durotomy.<sup>25,37</sup> Xu et al.<sup>41</sup> reported 6.25% durotomies with no CSF leakage,

while Castro-Menéndez et al.<sup>2</sup> reported a higher rate of 10%, mainly in the first half of the patients. Similarly, unintentional durotomies in this study occurred to a larger extent within the first third and disappeared within the last group of operated patients, which is due to the increasing experience of the operators. Moreover, the incidence of dural tears is directly proportional to the severity of stenosis and surgical technique, as mentioned by Pao et al.<sup>24</sup> Consequently, Stadler et al.<sup>31</sup> have recommended using special equipment while performing EDL and keeping ligamentum flavum until ending the bony work to minimize the risk of incidental durotomies.

There is a statistically significant higher rate of CSF leakage in open laminectomy than in EDL with an increased likelihood of reoperation, as concluded by Wong et al.<sup>39</sup> Maximal preservation of facet joints is of utmost importance to stop the progression of postoperative spinal instability.<sup>21</sup> Based on a biomechanical study conducted on the cadaveric human lumbar spine, Hamasaki et al.<sup>5</sup> stated that the EDL approach could leave the spine 80% more stable than its preoperative state. Another notable critical complication is an epidural hematoma. Castro-Menéndez et al.<sup>2</sup> have reported one patient with compressive epidural hematoma complicated with cauda equina syndrome that required urgent decompression. No epidural hematomas occurred in the current study, similar to the findings of Lee et al.<sup>18</sup>, which may be due to careful hemostasis. In line with Ikuta et al.<sup>10</sup> and Pao et al.,<sup>24</sup> postoperative neural complications in the form of transient dysesthesia due to manipulation were observed in 6% of patients; however, dysesthesia was mild and resolved gradually. Thus, minimal, delicate manipulation and earlier dissection of adhesion of neural structures are essential for minimizing these complications and the usage of high-intensity bipolar cautery should be avoided around neural structures. Postoperative radiological investigations were not routinely used in our study. As we mentioned before, there is no significant

relationship between the extent of radiological decompression and clinical outcomes, so we mainly depended on clinical symptoms and signs as the main outcome measure.<sup>7,8</sup>

One of the shortcomings of our study is the relatively small number of patients as a large number of patients will strengthen the outcome parameters. Another shortcoming is that not all patients had postoperative CT scans as we did not like to expose our patients to the effect of extra radiation and due to the noncompliance of patients.

## CONCLUSION

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

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## العنوان العربى

### فعالية الأسلوب أحادي الجانب بالمنظار في إدارة ضيق القناة القطنية احادى القطعة

**البيانات الخلفية:** تم استخدام تقنيات جراحية مختلفة لعلاج ضيق القناة الشوكية ، بما في ذلك جراحة إزالة الضغط المفتوحة والأنبوبية والجراحة الدقيقة وجراحة الدمج.

**الغرض:** التحقق من سلامة وفعالية استخدام التنظير الداخلي للمرضى الذين يعانون من ضيق القناة الشوكية القطنية التنكسية أحادية القطعة.

**تصميم الدراسة:** دراسة حالة سريرية مستقبلية.

**المرضى والطرق:** تم علاج 30 مريضاً على التوالي يعانون من ضيق القناة القطنية باستخدام المنظار. عولج المرضى بنظام GO EASY من الجيل الثاني (كارل شتورز ، توتلينجن ، ألمانيا) ، في أقسام جراحة المخ والأعصاب بمستشفيات جامعة الإسكندرية وكفر الشيخ ، بين مارس 2018 وسبتمبر 2020. وشملت معايير النتائج الأولية المقياس التناظري البصري (VAS) و مؤشر اوسويستري (ODI) لقياس الألم والعجز ، على التوالي. تم حساب طول الشق ومدة الجراحة وفقدان الدم الجراحي ومدة الإقامة في المستشفى. كان متوسط فترة المتابعة للمرضى 9 أشهر (المدى ، شهرين إلى 12 شهراً).

**النتائج:** كان متوسط العمر  $56.5 \pm 5.7$  سنة. كان جميع المرضى يعانون من عرق النساء العرج. 63% (19 حالة) لديهم عرق النساء ثنائي الجانب ، بينما 37% لديهم عرق النساء أحادي الجانب. 66% (20 حالة) يعانون من آلام أسفل الظهر. 7 مرضى (23%) لديهم ضعف حركي قبل الجراحة. 22 حالة بين الفقرتين الرابعة والخامسة ، 6 حالات بين الفقرتين الثالثة والرابعة وحالة واحدة للمستويين بين الفقرتين الثانية والثالثة و بين الفقرتين الخامسة قطنية والاولى عجزية. كان هناك انخفاض ذو دلالة إحصائية في متوسط قيم VAS لكل من الآلام الجذرية وآلام الظهر في فترة المتابعة ( $P > 0.001$ ). أيضاً ، كان هناك انخفاض معتد به إحصائياً لقيمة ODI المتوسطة في فترة المتابعة ( $P > 0.001$ ). كان فقدان الدم الجراحي  $147.2 \pm 68.3$  مل. كان متوسط وقت التشغيل  $134.7 \pm 28.34$  دقيقة. كان متوسط مدة الإقامة في المستشفى  $1.4 \pm 0.8$  يوم (المدى ، 1-3 أيام). كان لدينا أربعة مرضى تمزق الجافية أثناء العملية (13%) دون حدوث تسرب للسائل النخاعي بعد العملية الجراحية ، وثلاثة مرضى (10%) أصيبوا بعدوى جرح سطحية ، لا كان المرضى يعانون من التهاب أو التهاب في الجروح العميقة ، ولم يحتاج أي مريض تكرار الجراحة في فترة المتابعة.

**الخلاصة:** يعتبر أسلوب التنظير الداخلي أحادي الجانب هو تقنية آمنة وفعالة في المرضى الذين يعانون من تضيق الفقرات القطنية التنكسية. يسمح بإزالة الضغط بشكل كافٍ عن العناصر العصبية ويحافظ على استقرار العمود الفقري.