ORIGINAL ARTICLE

Prospective Study of 103 Consecutive Patients with Lumbar Spinal Stenosis Treated by Uniportal Percutaneous Endoscopic Lumbar Decompression: A 2-Year Follow-Up

Narongsak Bamrungthin, MD[1]

[1] Department of Orthopedic, Chaiyaphum Hospital, Chaiyaphum, Thailand

Objective: To evaluate the clinical outcomes and complications in patients with lumbar spinal stenosis that undergone uniportal percutaneous endoscopic lumbar decompression to two-year follow-ups.

Materials and Methods: A percutaneous endoscopic lumbar decompression with a unilateral foraminal approach was used in patients with a single level of lumbar spinal stenosis. One hundred and three were enrolled in the present study. Clinical outcomes such as back and leg pain by visual analog scale (VAS), Oswestry Disability Index (ODI), McNab clinical outcome score, neurogenic claudication by maximum walking distance, and complications were recorded pre-operation and post-operation at day 1 and 1, 3, 6, 12, and 24 months after surgery. Statistical significance was established at p smaller than 0.05.

Results: All patients displayed clinical improvement when evaluated with VAS scores for back and leg pain, while ODI, neurogenic claudication sign, and Macnab criteria decreased statistically and significantly (p=0.05). The Macnab criteria showed a good or better outcome in 92.85%. There were no serious complications and only three patients were found to have minor dural tears.

Conclusion: An uniportal percutaneous endoscopic lumbar decompression is a minimally invasive surgical procedure used to treat lumbar spinal stenosis. It is safe and effective. The advantages of uniportal percutaneous endoscopic lumbar decompression include a shorter hospital stay, faster recovery time, and less postoperative pain. However, as with any surgery, there are risks and potential complications, and the learning curve is steep.

Keywords: Endoscopic; Laminectomy; Spinal stenosis; Percutaneous endoscopic decompression

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Lumbar spinal stenosis (LSS) is the narrowing of the spinal canal caused by degeneration and arthritic changes in the lower lumbar spine. These changes include bulging discs, ligamentum flavum hypertrophy, and osteophyte formation, especially at spinal facet joints. Stenosis can compress nerve roots and is one of the most prevalent degenerative conditions that affect older individuals[1]. Signs and symptoms usually consist of a combination of low back pain, pain to the buttocks or lower legs, numbness, tingling, weakness of the lower extremity, cauda equina syndrome, and neurogenic claudication[1,2]. These symptoms are especially extant when standing upright or walking and can usually be relieved by leaning forward or sitting down. LSS can be classified into three categories according to pathological zone, comprising central stenosis, lateral recess stenosis, and foraminal stenosis. Initial conservative treatment of LSS typically includes medications, physical therapy, and epidural steroid injection. However, surgical treatment will be considered for patients with more severe symptoms such as severe pain, progressive motor deficits, cauda equina sign, and failed conservative treatments[3,4]. An open decompression laminectomy is the gold standard surgical option for treating spinal stenosis[2,5]. This surgery removes the bony spurs and buildup of bone in the spinal canal, providing more room for the spinal cord and nerves. Recently, minimal invasive spinal surgery (MIS) has been used to treat LSS, which reduces blood loss,

Correspondence to:

Bamrungthin N.

Department of Orthopedics, Chaiyaphum Hospital, Chaiyaphum 36000, Thailand.

Phone: +66-97-3260505

Email: dr-herm-@hotmail.com

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post-operative pain, and length of stay. Nonetheless, MIS also has pitfalls, such as injuries to the paraspinal muscles, restricted intraoperative view, and technical difficulties[2,5,6]. More recently, uniportal percutaneous endoscopic lumbar decompression has been reported in the literature and used to treat LSS safely and effectively[3,6-9]. The goal of the procedure is to relieve pressure on the spinal cord and nerve roots. The purpose of the present study was to evaluate the clinical outcomes and complications of LSS for those undergone uniportal percutaneous endoscopic lumbar decompression.

Materials and Methods

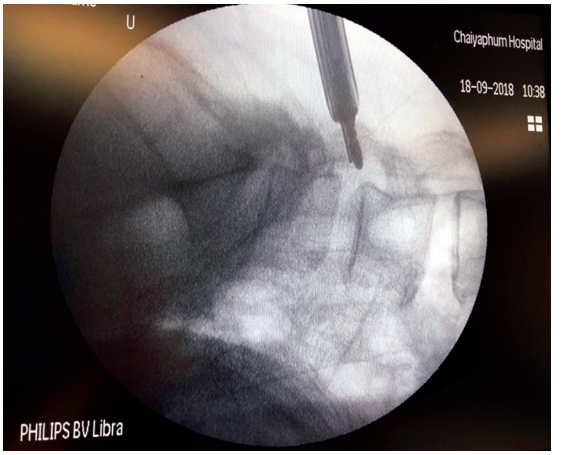
The present study included 128 patients with LSS who undergone spinal surgery at Chaiyaphum Hospital between October 2017 and September 2019. The inclusion criteria were patients with one level of LSS predominated leg pain, neurogenic claudication with or without motor deficit, failed conservative treatments for more than six months, and cauda equina syndrome. The exclusion criteria were patients with predominated back pain, spondylolisthesis more than Meyerding Grade I, and scoliosis and spinal instability. The present study was approved by the Chaiyaphum Hospital Ethics Committee (approval No. 042/2017) and obtained informed consent in all cases. The patients were diagnosed by clinical findings and magnetic resonance imaging (MRI). All patients were evaluated and recorded pre-operatively for demographic data, surgical technique, and neurological assessment. Surgical procedures were performed by a single surgeon. After surgery, the patients received follow-ups at 1, 3, 6, 12, and 24 months postoperatively to evaluate back and leg pain by visual analog scale (VAS), Oswestry Disability Index (ODI), McNab clinical outcome score, neurogenic claudication by maximum walking distance, and complications. The data from each follow-up was recorded by an independent observer.

Surgical procedure

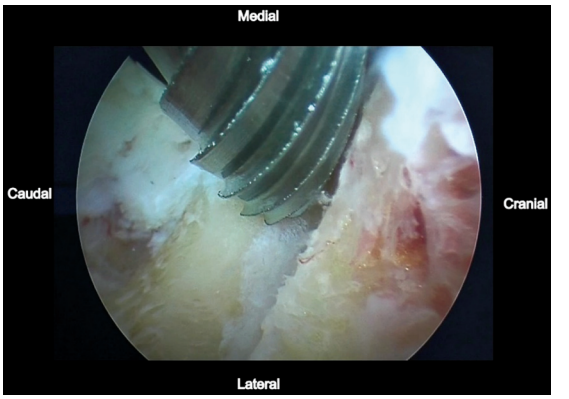
Uniportal percutaneous endoscopic lumbar decompression is a minimally invasive surgical procedure used to treat LSS, a condition that causes narrowing of the spinal canal in the lower back. The goal of the procedure is to relieve pressure on the spinal cord and nerve roots. That surgery is currently performed under general anesthesia. In all cases, the approach was performed on the side with the most prominent symptoms. The patient was set in a prone position. In the case of lateral spinal stenosis, a 1 cm-long paramedian skin incision was made on the side with the predominant radicular symptoms. A blunt dilator, followed by an endoscopic working sleeve, was inserted toward the inferomedial edge of the upper lamina. Ipsilateral laminotomy was performed using a high-speed burr and Kerrison punches under direct endoscopic visual control and continuous fluid irrigation. After the access was created, the bony structures were exposed. It might be helpful to start decompression at the caudal end of the descending facet. Depending on the pathology, decompression was then commenced with resection of the medial parts of the medial descending facet, the cranial and caudal lamina, and the ligamentum flavum. The extent of decompression continued caudally to half of the pedicle. The medial portions of the ascending facet and the ligamentum flavum were then resected until sufficient decompression of the neural structures could be clearly seen. Finally, it might be necessary to remove the protruding annulus part and osteophytes in the ventral epidural space (Figure 1). In the case of central spinal stenosis, a unilateral approach was carried out with "over-the-top" access using the undercutting technique to the opposite side. For this

(A) Intraoperative during an uniportal percutaneous endoscopic lumbar decompression

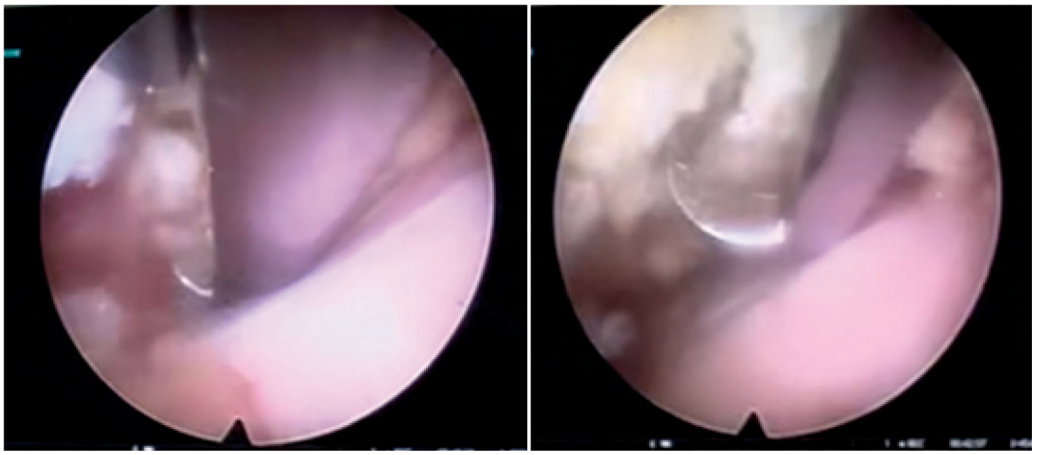
Figure 1. An uniportal percutaneous endoscopic lumbar decompression procedure.



(B) Bone drilling tip of ascending process in lateral lumbar spinal stenosis



(C) The medial portions of the ascending facet and the ligamentum flavum resected which opens the access to the spinal canal



(D) Ipsilateral and contralateral decompression: tilting optics towards the contralateral side will enable an adequate view of the contralateral neural structures. Kerrison punches and sharp scissors are utilized to remove the yellow ligament contralaterally in a "cross-over" or "over-the-top" technique

Figure 1. (continued).

purpose, the bone in the ventral area of the spinous process was resected until the contralateral side could be accessed dorsally up to the dura of the spinal cord. If possible, the ligamentum flavum was initially left in place to protect the dura, and bony decompression was carried out again by laminotomy and partial facetectomy. Generally, the ligamentum flavum needed to be completely resected medially to the midline. Finally, the contralateral recess needed to be extended. The decompression was completed when the dura and spinal nerves had clearly decompressed.

Statistical analysis

Demographic data were divided into quantitative and qualitative data. Quantitative data distributions were analyzed with the Kolmogorov-Smirnov test. Mean and standard deviation (SD) were used for describing continuous data. Percentage was used for describing the category data. Repeated measures ANOVA was used to compare the mean of clinical outcomes in each period after uniportal percutaneous endoscopic lumbar decompression. Data were considered significantly different at p-value less than 0.05. All the data were analyzed using the Stata Statistical Software, version 16 (StataCorp LLC, College Station, TX, USA).

Results

One hundred twenty-four patients with LSS undergone spinal surgery, and 103 patients who met the inclusion criteria for uniportal percutaneous endoscopic lumbar decompression were included in the present study. Twelve patients had problems and needed open spine surgery, while three patients had spine surgery at more than one level, and six patients who had previous spinal surgery were excluded. The

Table 1. Demographic data and surgical characteristics of participants (n=103)

Characteristics	Mean±SD
Age (years)	54.90±8.84
Onset before surgery (months)	24.11±8.26
Time for surgery (minutes)	67.05±26.69
Length of stay (days)	4.11±2.21

SD=standard deviation

Table 2. Demographic data and surgical characteristics of participants (n=103)

Characteristics	n (%)
Level of surgery (n=105)	
L2-L3	2 (0.95)
L3-L4	7 (6.67)
L4-L5	89 (84.76)
L5-S1	7 (6.67)
Type of spinal stenosis	
Lateral canal stenosis	65 (61.90)
Central canal stenosis	40 (38.09)
Neurological deficit	52 (50.48)
Motor deficit	41 (39.08)
Impaired sensation	45 (43.68)
Bowel and bladder symptom	10 (9.07)

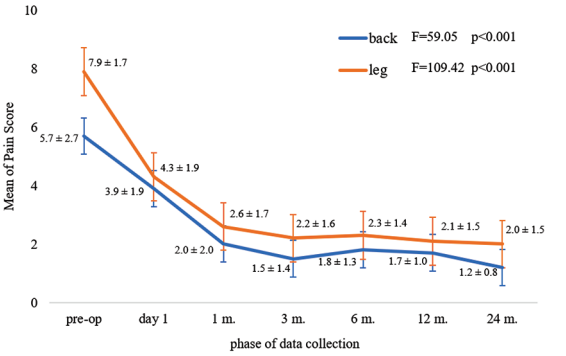


Figure 2. The mean of back and leg pain in pre-operative and post-operative phases.

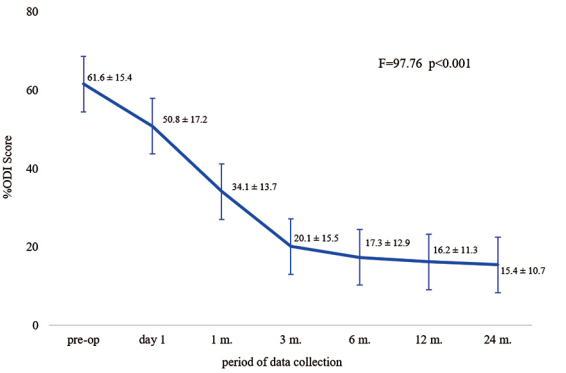


Figure 3. The mean of Oswestry Disability Index (ODI) in pre-operative and post-operative

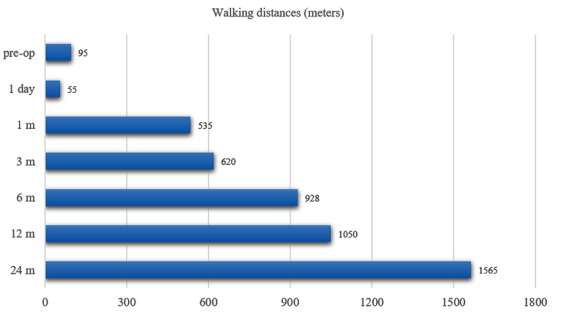


Figure 4. The mean walking distances in pre- and post-operative phases.

mean follow-up period was 18.56 months (range 12 and 24). The patients ranged from 44 to 76 years of age, with the mean age of the patients being 54.90±8.8 years. The patients had symptoms of lumbar stenosis for a mean length of 24.11 months (range 6 to 60). Typically, the side chosen for the surgical approach was the clinically more symptomatic side. The operative time for a single-level procedure ranged from 35 to 120 minutes, with an average of 67.05 minutes. No patient received blood transfusion, and the mean length of hospitalization was 4.11 days (Table 1).

Clinical outcomes

LSS was done at the L4 or L5 level on 84.46% of the patients, while 38.89% had central spinal stenosis, and surgical treatment was necessary to cross the contralateral spinal canal for bilateral decompression. Moreover, 50.48% of the patients had neurological deficits such as motor deficits, cauda equina symptoms, and neurogenic claudication resulting in decreased ability to walk (Table 2).

All preoperative and postoperative data were available for outcome analyses one day after surgery, and at 1, 3, 6, 12, and 24 months after surgery. The mean back and leg pain assessed by the VAS scores, and ODI scores were statistically and significantly decreased (p=0.05) The Macnab criteria showed a good or better outcome in 92.85%. The ability to walk was statistically and significantly improved after one month. The distance for walking duration one month after surgery ranged between 200 to 1,500 meters, with an average distance of 535 meters (Figure 2-4).

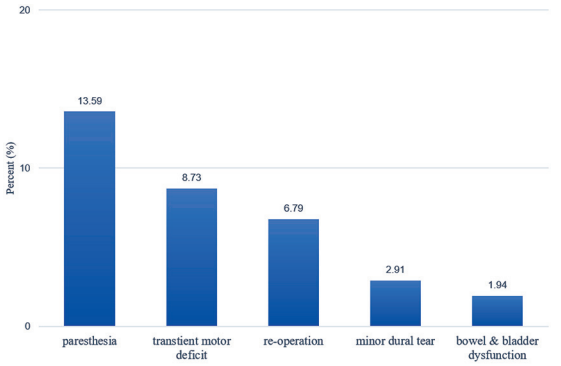


Figure 5. The percentage of complications after uniportal percutaneous endoscopic lumbar decompression.

Peri and post-operative complications

No perioperative death, serious complications relating to uniportal percutaneous endoscopic lumbar decompression, postoperative epidural hematoma, or superficial infection were noted. Accidental minor dural tears occurred in three patients (2.91%), who were treated with primary sutures under endoscopic, and bed rest. The perioperative complications occurred at the beginning of the learning curve. During the follow-up period, seven patients (6.79%) had persistent/constant leg pain, and neurogenic claudication needed for reoperations consisted of open spinal decompression and fusion to treat clinical relapse. Fourteen patients (13.59%) had transient paresthesia, eight patients (8.73%) had mild weakness of myotome involving the level of surgery, and one patient (1.94%) had bowel and bladder symptoms. All cases were resolved spontaneously within three months by conservative management (Figure 5).

Discussion

An open decompression laminectomy is considered the gold standard form of surgery for the treatment of LSS. Recently, minimally invasive techniques have been developed to preserve the surrounding normal anatomical structures, such as muscles, ligaments, and the spine[5]. An uniportal percutaneous endoscopic lumbar decompression has gained popularity in the treatment of patients with lumbar stenosis, although it remains a challenging procedure, even for experienced endoscopic surgeons[6,8].

This prospective study reported on the clinical outcomes and complications in patients who undergone uniportal percutaneous endoscopic lumbar decompression. The majority of patients (84.46%) experienced statistically significant reductions in mean back pain, leg pain, and ODI scores ($p=0.05$). The Macnab criteria showed a good or better outcome in 92.85% of cases, and there was a statistically significant improvement in neurogenic claudication, as assessed by the mean distance walked. The mean walking distance increased significantly from 95 meters in the preoperative phase to 535 meters postoperatively after one month ($p<0.001$). These results are consistent with a literature review of 423 patients undergone uniportal endoscopic interlaminar lumbar decompression, which showed satisfactory outcomes with 82% of patients reporting no leg pain and 13% experiencing only occasional pain[10]. A systematic review evaluating the effectiveness of transforaminal endoscopic surgery for lumbar stenosis from 1973 to November 2009 reported patient satisfaction rates ranging from 69% to 83%[11-13], and an 85% improvement in walking ability[12].

In the present study, there were complications. Three patients (2.91%) experienced perioperative minor dural tears, with all cases occurring in patients with central LSS. These perioperative complications were observed at the beginning of the learning curve, and all occurred in patients with central canal spinal stenosis. Additionally, 13.52% of patients experienced transient paresthesia, which improved with medication within one to three months. Seven patients (6.79%) reported persistent or constant leg pain and neurogenic claudication that required reoperations involving open spinal decompression and fusion for treatment. The rate of complications observed in the present study was similar to the previous studies, which reported serious complications ranging from 0% to 8.3%[11,13,14].

Complications to the neural structure may be caused by surgical procedures, in which an extended and uninterrupted excessive retraction of the neural structure with the working sleep in a medial direction must be avoided, particularly in cranial areas, or only carried out intermittently, to avoid the risk of neurological damage. Experience indicates that there is typically an enhanced risk of problems occurring during the learning curve, as with all new techniques. The present study involved central spinal stenosis in 38.09% of the cases, which a surgeon must address carefully, especially during a contralateral decompression procedure.

Overall, uniportal percutaneous endoscopic lumbar decompression has demonstrated promising clinical outcomes in terms of pain reduction,

improved functional ability, shorter hospital stays, faster recovery time, and patient satisfaction. However, it is important to consider the potential risks and complications associated with the procedure. It should be noted that performing uniportal percutaneous endoscopic lumbar decompression requires expertise in surgery. The present study had limitations since it had been prospective and focused only on patients who undergone uniportal percutaneous endoscopic lumbar decompression. Therefore, it is necessary to compare uniportal percutaneous endoscopic lumbar decompression with another surgical protocol to assess long-term clinical outcomes, such as instability and the need for re-operation. Further investigations with long-term results are required due to lack of postoperative imaging parameters to evaluate postoperative muscle injury and postoperative segmental instability.

Conclusion

Uniportal percutaneous endoscopic lumbar decompression is a minimally invasive surgical procedure for treating LSS that is considered safe and effective. Advantages of uniportal percutaneous endoscopic lumbar decompression include a shorten lengths of hospital stay, rapid recovery time, and reduced postoperative pain. However, it is important to note that there are risks and potential complications associated with the procedure as for any surgical procedure. Additionally, it is worth mentioning that the learning curve for performing uniportal percutaneous endoscopic lumbar decompression is steep. Further research is needed to evaluate the long-term clinical outcomes and compare uniportal percutaneous endoscopic lumbar decompression with other surgical approaches.

What is already known on this topic?

An uniportal percutaneous endoscopic lumbar decompression stands as a safe and effective method for the treatment of single-level spinal stenosis. The notable benefits of this minimally invasive surgical approach include decreased tissue and bony trauma, reduced intraoperative blood loss, minimal post-surgical scarring, and a shorter duration of hospitalization. The key successes of uniportal percutaneous endoscopic lumbar decompression are intensive surgical training and proper patient selection.

What does this study add?

An uniportal percutaneous endoscopic lumbar decompression is a minimally invasive approach to spine surgery used to treat both unilateral and bilateral spinal stenosis by a single endoscope. An "over-the-top" approach is an undercutting method to access the contralateral for effective stenosis clearance, thereby minimizing damage to bone and surrounding tissues during the surgical process.

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Conflicts of interest

The author declares no conflict of interest.

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