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# Full endoscopic lumbar decompression of spinal stenosis through uniportal approach. Technique and preliminary results

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## ABSTRACT

**Introduction:** To investigate the certain advantages of full endoscopic lumbar decompression (FELD) surgery over conservative techniques in lumbar spinal stenosis (LSS). Minimal invasive techniques have been introduced recently to treat lumbar spinal stenosis and gained popularity over conservative techniques because of the minimal tissue damage along with the satisfactory postoperative outcome. In our study, the FELD technique using a uniportal approach is described and investigated in accordance with the preliminary clinical results of patients who had degenerative spinal stenosis.

**Methods:** 55 patients who underwent FELD were retrospectively reviewed. General demographics and parameters including operation time, length of hospital stay, mean time to return to work, complications were recorded. Clinical outcomes were evaluated using the visual analogue scale (VAS) for low back and leg pain, Oswestry Disability Index (ODI) for functional assessment.

**Results:** The mean follow-up time was 36 months. There was no measurable intraoperative blood loss. The mean operating time was 97,4 minutes. The length of hospital stay after the operation was 27 hours on average. The difference between preoperative and postoperative VAS scores was statistically significant ( $p < 0.001$ ). No surgery-related complication was noted.

**Conclusions:** Amongst other standard techniques, FELD has the technical advantages of less paraspinal muscle dissection, less tissue trauma, less risk of spinal instability, minimal blood loss, quicker postoperative recovery and shorter length of hospital stay.

## INTRODUCTION

Degenerative lumbar stenosis is caused by the hypertrophy of the surrounding bone structures and disco-ligamentous complex and it is more prevalent in the elderly. The compression may cause clinical symptoms of neurogenic claudication with radicular signs. Back pain is more likely attributable to the degenerative process, such as segmental instabilities or deformities.

**Keywords**  
endoscopic,  
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As minimal invasive techniques, biportal endoscopic decompression technique and uniportal full endoscopic lumbar decompression technique have been introduced recently and it has been reported to have favorable clinical results and less muscle damage for lumbar spinal stenosis and has begun to attract attention. Since then, several studies were reported satisfactory results with a follow-up of more than two years after unilateral biportal endoscopic lumbar decompression<sup>8,9,13</sup>. Thus, FELD has been suggested as an alternative to open laminectomy.

This study evaluates the short-term outcome of unilateral uniportal endoscopic spinal surgery for degenerative spinal stenosis instead of biportal approach.

## MATERIAL AND METHODS

In this study, 55 patients with symptomatic degenerative lumbar stenosis, who underwent FELD operation between 2014 and 2015 were evaluated retrospectively. The indication for surgery was defined according to present-day standards based on radiographic images, radicular pain symptoms or neurogenic claudication unresponsive to conservative treatment and progressive neurological deficits<sup>3</sup>. Ethical approval was obtained from the ethical committee and a written informed consent was obtained from participants in the study prior to surgery.

Preoperative and postoperative imaging data, including magnetic resonance imaging (MRI) and computed tomography (CT) images were collected. Follow-up visits were conducted on 3rd, 12th and 36th month as the final follow up. Clinical examination was made during the follow-up visits. In addition to general parameters, pain related information was obtained using these questionnaires: VAS for back and leg pain and ODI for functional assessment.

Clinical inclusion criteria was neurogenic claudication with unilateral or bilateral leg pain with or without paresis. Exclusion criterias were predominant back pain, mono segmental recess stenosis, foraminal stenosis in the lower level, coexisting disc herniation, degenerative spondylolisthesis with maximum Meyerding Grade I, multidirectional rotation slide,, scoliosis (maximum curvature 20°), prior surgery of the same segment.

## FULL-ENDOSCOPIC INSTRUMENTS

The working sheath has an outer diameter of 10 mm and an opening with an oblique tip that enables enhanced visualization. Insertion of the working sheath is made bluntly using a dilator. An optic with an outer diameter of 9.5mm is inserted through the working sheath. The optic contains an intraendoscopic, excentric working canal with a diameter of 5.7 mm, a light conductor system, a canal for continuous irrigation and a rod lens system. The angle of vision is 25 degrees. Various instruments including drills up to 5.5 mm in diameter can be used through the working canal. All of the operating instruments and optic products were supplied by the WOLF company (Richard Wolf GmbH, Knittlingen, Germany).

## OPERATIVE TECHNIQUE

The full-endoscopic interlaminar operation technique was described previously in the literature.<sup>17-19</sup> Under general anesthesia, patients are positioned in prone position under radiographic control (Figure 1). A dilator is inserted bluntly to the lateral edge of the interlaminar window and an operating sheath with an oblique opening is directed toward the ligamentum flavum under constant irrigation. The identification of the medial edge of the ascending facet is made, normal anatomy is recognized (Figure 2). Then ipsilateral decompression is achieved by cranial and caudal laminectomy, partial facetectomy, and ligamentum flavum resection. Then on the contralateral side of the dorsal dura, the ligamentum flavum is initially left intact in order to protect the dura and craniocaudal laminectomy, partial facetectomy is performed (Figure 3). Subsequently, the ligamentum flavum is completely resected. The decompression is concluded when the dura and the spinal nerves are adequately decompressed on both sides (Figure 4). None of the patients had intradiscal nucleotomy along with the fenestration of the annulus.

## STATISTICAL ANALYSIS

Numerical variables expressed by mean, standard deviation. Statistical analysis was calculated using the SPSS (Statistical Package for Social Sciences) version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). Paired t-test were applied to compare the

preoperative and postoperative VAS, ODI parameters.  $p < 0.05$  was considered significant.

## RESULTS

### Study group

There were 21 female and 34 male patients aged between 44 and 84 years (mean 58,2 years). The duration of symptoms ranged from 2 to 78 months (mean 19 months). Preoperative average walking distance of the patients was 30 meters.

45 interventions were performed at the L4-L5 level, L3-L4 level was operated on five patients; L5-S1 level was operated on two patients; L1-L2 level was operated on two patients; L2-L3 level was operated on one patient.

Throughout 12 patients who were under the age of 50, 9 patients were operated on the L4-5 level, one patient on the L1-2, one patient on the L3-4 and one patient on the L5-S1 level. No recurrence or complication was noted.

Throughout the rest of the patients who were over 50 years old, 37 patients were operated on the L4-5 level, four patients on the L3-4, one patient on the L1-2, one patient on the L2-3 level. Same as the young age group, no recurrence and complications were noted.

### Perioperative and postoperative outcome

The mean operating time was 97,4 minutes (65 to 120min). There was no measurable blood loss. Adequate bleeding control was achieved via continuous irrigation and the use of radiofrequency bipolar coagulation. The patients were mobilized five hours after the operation depending on the effects of the anesthesia. Overall hospital stay was 27 hours on average and mean time to return to work was 14 days.

There were 3 cases of back pain in which the patient recovered well following physical therapy and 5 cases of paresthesia that gradually improved following 2 – 3 weeks of rehabilitation. There were no other complications such as dural tear, hematoma, delayed wound healing, softtissue infection, spondylodiscitis, cauda-equina syndrome or thrombosis. All procedures were successfully completed via endoscopic approach, there was no need to convert to an open approach.

### Clinical Outcome

Significant reduction of radicular pain was noted

postoperatively, along with the statistically significant results of VAS and ODI questionnaires.

Preoperative VAS leg score on the affected side was  $7.9 \pm 1.1$  and the postoperative VAS leg score improved to  $1.1 \pm 0.7$  early postoperatively. The improvement was statistically significant ( $p < 0.001$ ). Significant improvement of VAS leg scores was achieved on 3rd month, 12th month and 36th month follow-up visits,  $0.3 \pm 0.5$ ,  $0.2 \pm 0.5$  and  $0.1 \pm 0.3$  respectively ( $p < 0.001$ ). Significant improvement of VAS back scores was noted on 3rd month, 12th month and 36th month follow-up visits,  $1.6 \pm 0.7$ ,  $1.01 \pm 0.8$  and  $0.9 \pm 0.9$ , respectively ( $p < 0.001$ ). ODI scores changed from  $48.2 \pm 21.9$  preoperatively to  $26.6 \pm 7.9$  early postoperatively ( $p < 0.001$ ). Significant improvement was noted on 3rd month, 12th month and 36th month follow-up visits,  $20.4 \pm 5.6$ ,  $14.5 \pm 5.5$  and  $12.8 \pm 5.4$  ( $p < 0.001$ ) respectively. Furthermore, significant development in the walking distance of the patients was observed statistically. Walking distance increased from  $30.7 \pm 14.4$  meters to  $124.3 \pm 38.8$  meters early postoperatively ( $p < 0.001$ ). Significant improvement in walking distance was noted on 3rd month, 12th month and 36th month final follow-up visits;  $301.2 \pm 81.1$  meters,  $682 \pm 86.2$  and  $703.6 \pm 202.2$  meters respectively ( $p < 0.001$ ).

## DISCUSSION

Lumbar spinal stenosis is the result of a degenerative process, including facet joint hypertrophy, loss of intervertebral disc height, disc bulging, osteophyte formation, and hypertrophy of the ligamentum flavum<sup>1</sup>. The hallmark of spinal stenosis is neurogenic claudication, consisting of lower limb pain and neurological symptoms exacerbated by walking<sup>19</sup>. Nonetheless, people with LSS often avoid walking and have reduced walking capacity because of the pain and discomfort in the lower extremities during walking<sup>10,21</sup>. The LSS patients also suffer from physical impairments including poor balance, sensory loss (numbness or tingling), and muscle weakness in the lower extremities<sup>10, 11</sup>. Symptoms are generally intermittent and posture-dependent. Mostly they appear with standing for a long time and lumbar extension. The symptoms usually worsen by walking and they are relieved by rest in a flexed or seated position. Radicular pain may be due to a combination of mechanical compression, inflammatory irritation of neural elements, vascular congestion and segmental instability<sup>1</sup>.

Depending on the severity of stenosis, various kinds of treatments are available, from surgical procedures to conservative methods. Open microscopic laminectomy procedure has been the common standard surgical treatment method for various types of lumbar spinal stenosis. The standard surgery procedure requires, followed by laminectomy and excision of hypertrophic ligamentum flavum for decompression. The multifidus muscle injury and muscle atrophy occur frequently after posterior lumbar spine surgery, and they are associated with lower back pain and functional disability<sup>7</sup>. Postoperative iatrogenic instability following microscopic laminectomy procedure, is a possible postoperative outcome of this technique. However, it has been reported to occur rarely following these procedures. Silvers et al. reported that lumbar instability rarely occur after open laminectomy procedure<sup>20</sup>. Since several studies have reported favorable long-term results, the technique is currently considered the standard technique<sup>2,6</sup>.

Nowadays, the main goal is to preserve normal anatomical spinal alignment without causing postoperative spinal instability. It has been shown that standard microsurgical lumbar decompression may lead to iatrogenic muscle injury and spinal instability, requiring additional surgical intervention for stabilization<sup>5</sup>. Regarding these complications, minimal invasive techniques have been introduced recently. On 2015, Komp et al. reported bilateral full-endoscopic decompression with equivalent clinical results and less complication rate, less operation time when compared to standard microsurgical laminectomy<sup>14</sup>.

Minimal invasive techniques include bilateral decompression using biportal unilateral approach and uniportal unilateral approach for patients with lumbar stenosis<sup>9, 13, 16</sup>. The difference between uniportal and biportal technique is the number of the portals in use during the operation. Biportal technique requires two portals whereas uniportal technique requires only one portal for the endoscope and the remaining endoscopic instruments. There isn't adequate proof of one's superiority, since it depends on the surgeon's experience with the technique<sup>9</sup>.

Via uniportal endoscopic technique, there may be no need to make a large facet resection intraoperatively, except when there is hypertrophy

of the superior facet that compresses the spinal cord through lateral recess. With the novel endoscopic instruments providing better visual control, stability of the facet joint is not violated significantly while resecting bone elements and this prevents lateral wedging motion of the vertebral segment which maintains stability even after decompression. This technique also allows an extended view of the foramen and lateral recess, especially of the contralateral side, adequately. An enhanced visualization may lead to less neural injury, with adequate decompression of lateral recess and neural foramen on both ipsilateral and contralateral sides.

The procedure is performed under general anesthesia with a 1cm vertical incision for each level. This minimal invasive technique with minimal incision site thus leads to less infection rate and it provides an opportunity for even elderly patients who have preexisting comorbidities prior to the procedure.

The benefits of FELD approaches include decreased blood loss, shorter operation time, shorter hospital stay, decreased postoperative narcotic requirement, decreased rate of infection and cerebrospinal fluid leak and a decrease in time to return to work. Lee et al. reported mean time of 2.4 days of hospital stay after uniportal endoscopic laminotomy for spinal stenosis<sup>15</sup>. In our study, despite the lack of comparison with lumbar microsurgery patients, mean time to return to work and total hospital stay is significantly short such as 14 days and 24 hours respectively. This result was consistent with the recent literature<sup>15</sup>.

As for complications, dural tear incidence is the most common complication noted during FELD surgery. In 2017, Kim et al. reported 6.25% cerebrospinal fluid leakage rate in 48 patients who had endoscopic lumbar decompression procedure<sup>12</sup>. Since our clinic has fair number of endoscopic cases, there hasn't been any serious complication perioperatively. We have encountered low infection rate and no cerebrospinal fluid leakage was noted. However, it is important to emphasize that the learning curve is steep for endoscopic operations and complications like cerebrospinal fluid leakage may occur at the beginning phase of this process.

As shown in the study of Bresnahan et al., preservation of the posterior elements via endoscopic techniques is associated with better

outcomes regarding lumbar spinal stability. Main conclusions of these studies are less tissue trauma, shortened rehabilitation period and less postoperative complications<sup>4,14</sup>. Since our study is a case series study, a comparison could not be stated, however, our results were consistent with the literature.

Along with these advantages, there are some certain disadvantages of the procedure, such as; the limited possibility of extending the approach in a case of possible neural injury or cerebrospinal fluid leakage and the steep learning curve of the procedure which may lead to higher complication rate at the beginning of the practice.

### CONCLUSIONS

The FELD operation through uniportal approach for lumbar degenerative stenosis is a sufficient and safe supplementation and alternative to the conventional microsurgical procedure. In our experience, the advantages of the procedure are; facilitation of the procedure via excellent visualization, good illumination, and expanded field of vision with 25 degrees optics; short operating time, adequate pain relief, reduced tissue trauma and rapid rehabilitation.

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