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Comparison of Bilateral Laminectomy with Unilateral Approach and Open Bilateral Laminectomy in Lumbar Spinal Stenosis

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ABSTRACT

Objectives: Lumbar spinal stenosis (LSS) is a frequent situation requiring decompression surgery, but there are different surgical approaches. The goal of this study was to compare the results of bilateral decompressive laminectomy via unilateral approach (BDLUA) and open bilateral decompressive laminectomy (OBDL) for single-level LSS. **Materials and Methods**: A retrospective study of 198 successive patients who had an operation for single-level LSS between October 2016 and May 2023 was performed. Eighty patients underwent BDLUA, while 118 patients underwent open OBDL. Visual Analog Scale (VAS) scores and walking times were noted preoperatively and 6 months postoperatively in all patients. Operative time, operative complications, hospital stay, operative blood loss, and iatrogenic spondylolisthesis rates at follow-up were also measured. **Results:** The mean age of the patients included in the study was 62.38±12.5 years. There was no statistically significant difference in VAS scores, walking times, duration of surgery, operative complications, and iatrogenic spondylolisthesis rates between the patients in the study who underwent BDLUA and the patients in the study who underwent OBDL ($p>0.05$). However, total blood loss during the surgical procedure and length of hospitalization were significantly shorter in patients who underwent BDLUA than those who underwent OBDL ($p<0.05$). **Conclusion:** Patients treated with a BDLUA and open OBDL had similar results regarding operative complications, VAS scores, operation time, and iatrogenic spondylolisthesis rates at follow-up. However, the duration of hospitalization and the quantity of intraoperative blood loss were significantly shorter in patients treated with the unilateral approach.

Keywords: Lumbar Laminectomy, Spinal Stenosis, Unilateral Approach.

Lomber Spinal Stenozda Tek Taraflı Yaklaşımla Bilateral Laminektomi ile Açık Bilateral Laminektominin Karşılaştırılması

ÖZ

Amaç: Lomber spinal kanal darlığı (LSKD), dekompresyon cerrahisi gerektiren sık görülen bir durumdur, ancak tedavide farklı cerrahi yaklaşımlar vardır. Bu çalışmanın amacı, tek seviyeli LSKD için tek taraflı yaklaşımla iki taraflı dekompresif lomber laminektomi (TYİDL) açık iki taraflı dekompresif lomber laminektominin (AiDL) sonuçlarını karşılaştırmaktır. **Gereç ve Yöntem:** Ekim 2016 ile Mayıs 2023 arasında tek seviyeli LSS için operasyon geçiren 198 ardışık hasta retrospektif olarak değerlendirildi. Seksen hastaya TYİDL, 118 hastaya AiDL uygulandı. Tüm hastalarda ameliyat öncesi ve 6 ay sonrasında Visual Analog Skala (VAS) skorları ve yürüme süreleri kaydedildi. Operasyon süresi, operasyon komplikasyonları, hastanede kalış süresi, operasyon sırasındaki kan kaybı ve iatrojenik spondilolistezis oranları ölçüldü. **Bulgular:** Çalışmaya dahil edilen hastaların yaş ortalaması 62.38±12.5 yıldı. TYİDL ve AiDL geçiren hastalar arasında VAS skorları, yürüme süreleri, ameliyat süreleri, ameliyat komplikasyonları ve takiplerinde iatrojenik spondilolistezis açısından istatistiksel olarak anlamlı bir fark yoktu ($p>0.05$). Ancak, TYİDL geçiren hastalarda operasyon sırasındaki toplam kan kaybı ve hastanede kalış süresi, AİDL geçiren hastalara göre anlamlı olarak daha kısaydı ($p<0.05$). **Sonuç:** TYİDL ve AİDL uygulanan hastalar, operasyon komplikasyonları, VAS skorları, operasyon süresi ve takipteki iatrojenik spondilolistezis oranları açısından benzer sonuçlar gösterdi. Ancak, hastanede kalış süresi ve operasyon sırasındaki kan kaybı miktarı, TYİDL uygulanan hastalarda anlamlı olarak daha kısaydı.

Anahtar Kelimeler: Lomber Laminektomi, Spinal Dar Kanal, Tek Taraflı Yaklaşım.

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INTRODUCTION

Lumbar spinal stenosis (LSS) is a common pathology that usually requires spine surgery in patients in the older age group of the population. Approximately half of patients diagnosed with symptomatic LSS have sensory or motor impairments (Katz et al., 1995). Usual symptoms include lower back pain, sensory deficits, leg pain, sphincter defects, and muscle weakness. Neurogenic claudication, characterized by a significant reduction in the ability to walk, is a typical manifestation of LSS and is the main reason for medical intervention (Szpalski & Gunzburg, 2003; Porter, 1996). LSS is caused by a narrowing of the diameter of the spinal canal, the diameter of the nerve root canals, and the diameter of the intervertebral neural foramen due to the progressive growth of bone and connective tissue elements surrounding the spinal canal. This can lead to neurogenic or vascular spinal canal content compression at one or more levels. The narrowing can be categorized as central (affecting the spinal canal diameter and dural sac), foraminal (affecting the spinal foraminal diameters), or lateral (affecting the lateral recess diameter).

Furthermore, LSS pathology is not only a structural process but also has a component of dynamic forces, as extension of the spine in the vertical axis and loading in the vertical axis can cause narrowing of the central and lateral canals (Schönström et al., 1989). There is no clarity in the current literature regarding the surgical approach to LSS, mainly whether fusion should be performed in addition to decompression. Some studies recommend fusion with lumbar decompression for LSS (Herkowitz & Kurz, 1991; Malmivaara et al., 2007). There are various techniques for surgical decompression in cases without fusion, each with different results. Our study aimed to compare the results of bilateral decompressive lumbar laminectomy via unilateral approach and open bilateral lumbar laminectomy for single level lumbar spinal stenosis.

MATERIALS AND METHODS

In this retrospective study, 198 consecutive patients who were diagnosed with single-level LSS and treated with decompressive surgery between October 2016 and May 2023 at the Clinic of Neurosurgery of Balikesir University Hospital were included. The main symptoms in the preoperative period were neurogenic claudication, leg pain, low back pain, or a combination of these symptoms. The mean duration from the onset of preoperative symptoms was 5±1.38 years. All patients in the study received a nonsteroidal anti-inflammatory or other analgesic agent preoperatively, and 122 patients underwent physical therapy.

The admittance criteria for this study were as follows: neurogenic claudication characterized by pain in the leg or limitation of walking or standing in an upright position, exercise intolerance, failure of conservative treatment methods, and compressive single-level central stenosis (central canal width < 12 mm in the sagittal axis) or lateral recess stenosis (width < 3 mm) by magnetic resonance imaging (MRI) or computed tomography. The rejection criteria for cases were as follows: isthmic spondylolisthesis, previous spine surgery at the same level, patients with congenital spinal stenosis with a central sagittal diameter of the bone canal < 8 mm due to the presence of short pedicles, motion instability determined by dynamic radiography studies with sagittal axis width > 3 mm vertebral translation and angulation greater than 10°, patients with multilevel spinal stenosis, and patients diagnosed with cauda equina syndrome.

Radiologic examination criteria were used to select the surgical approach. If it was determined that the patient's symptoms were caused by a single level, surgery was initiated. Surgery aimed to completely relieve the pressure in the spinal canal at the pathology level and in the nerve root canals at the same level. Patients were intubated and operated under general anesthesia. After anesthesia, the patients were placed on the surgery table in the prone posture. The operative level was localized using fluoroscopic guidance. After a midline skin incision was made at the affected level, the ligaments and paravertebral muscle tissues were dissected from the spinous processes using both blunt dissection and cautery, and the paravertebral muscles were dissected over the laminae using fine bone scraper gauze. Unilateral dissection was performed in cases of bilateral decompressive lumbar laminectomy with a unilateral approach, and bilateral dissection was performed in cases of open bilateral lumbar laminectomy.

Unilateral laminectomy using a surgical microscope was performed in cases of bilateral decompressive lumbar laminectomy. The most symptomatic side was identified, and a fascial incision was made on that side. If symptoms were not lateralized, the left-sided approach benefitted a right-handed surgeon. The paraspinal muscles were lifted off the spinous process and lamina through subperiosteal dissection. The surgical field was then prepared for the operating microscope. The ipsilateral cephalad lamina was partially removed using Kerrison rongeurs or a high-speed drill. A less extensive laminotomy was also performed on the caudal lamina. The ipsilateral ligamentum flavum was resected entirely using a Kerrison rongeur. Partial resection of the medial facet joint was then carried out. The compressed nerve root was located and decompressed by widening the foraminal space. Following the decompression on the ipsilateral side, the microscope was angled medially, and the patient was tilted contralaterally to improve the image of the contralateral nerve root. The base of the inferior surface of the contralateral lamina, spinous process, and the contralateral ligamentum flavum were removed using Kerrison rongeurs and high-speed milling for complete decompression of the contralateral nerve root and dura.

On the other hand, bilateral open bilateral lumbar laminectomy was performed, and bilateral laminae,

ligament flavum and spinous process were completely removed. In pathologically stenotic distances, total laminectomy was performed in addition to wide foraminotomies using a combination of high-speed air drills, bone rongeurs, and diamond burs. Both surgical techniques aimed to preserve the facet joints over the spinal roots and to create sufficient space for the nerve roots. No patient underwent discectomy or fusion. Bleeding was controlled by ensuring complete relaxation of the nerve roots. Muscles, skin, and fascia were closed with separate sutures.

A total of 80 patients underwent bilateral decompressive lumbar laminectomy via unilateral approach, while 118 patients underwent open bilateral lumbar laminectomy. Clinical evaluations were performed 6 months before and after surgical treatment. After inclusion in the study, the minimum follow-up period was 6 months. Visual Analog Scale (VAS) scores and walking time of all patients were recorded before and 6 months after surgery. VAS scores ranged from 0 (no complaint of pain) to 100 (worst possible pain complaint) units (Wewers & Lowe, 1990). Walking time is measured by the time the patient walks on level ground without stopping. Operation time, length of hospital stay, operative complications, operative blood loss, and iatrogenic spondylolisthesis rates at follow-up were also recorded for all patients.

Statistical analysis

The collected data was entered and analyzed using SPSS software version 26 (SPSS 26.0 IBM Corporation, Armonk, New York, USA). Statistical evaluation was performed using nonparametric tests, especially the Mann-Whitney U test and the chi-square test, to compare the differences. A p-value below 0.05 was considered statistically significant.

Ethical considerations

The whole study was carried out by the Declaration of Helsinki [1964]. All patients were informed verbally and in writing about the surgical treatment of lumbar spinal stenosis and signed informed consent forms. This study was approved by the Clinical Research Ethics Committee Balıkesir University Faculty of Medicine, (Decision No. 2023/164, Date: 22/11/2023).

RESULTS

A total of 198 female and male patients (96 female patients and 102 male patients) were included in this study. Operative and demographic details are shown in Table 1. The average age of the cases included in the study was 63.41±12.4 years. The mean duration of complaints before surgical treatment was 4±1.13 years. The average follow-up period after surgical treatment was 41.7±13.8 months. Decompressive surgery was performed on the L1 level lamina in five patients, L2 level lamina in 11 patients, L3 level lamina in 45 patients, L4 level lamina in 87 patients, and L5 level lamina in 50 patients.

In patients who underwent BDLUA, the mean VAS (Visual Analog Scale) score was 62.06±4.48 before surgical treatment, while this score decreased significantly to 26.81±4.74 after surgical treatment. Similarly, in patients who underwent OBDL, while the mean VAS score was 61.12±4.85 before surgical treatment, this value decreased significantly to 23.06±7.50 after surgical treatment. There was no significant difference between the VAS scores pre- and post-surgical treatment between both groups (p =0.21).

Table 1. Demographic and surgical data of all patients.

Variables	Findings
Age	63.41±12.4 years
Sex	102 male, 96 female
Duration of Symptoms	4±1.13 year
Follow up duration	41.7±13.8 months
Decompressed level	
L1-2	2.5% (5/198)
L2-3	5.5% (11/198)
L3-4	23% (45/198)
L4-5	44% (87/198)
L5-S1	25% (50/198)

The mean walking time of patients who underwent BDLUA increased from 21±3.4 minutes before surgical treatment to 58±4.8 minutes after surgical treatment. Similarly, in a study of patients who underwent OBDL, the mean walking time increased from 19±3.2 minutes before surgical treatment to 56±5.3 minutes after surgical treatment. There was no statistically significant difference between the two groups when walking time pre and post-surgical treatment was evaluated (p=0.33).

The average surgery time of cases who underwent BDLUA was 117±19.4 minutes, while the average surgery time of patients who underwent OBDL was 112±17.2 minutes. When the two groups were evaluated, there was no statistically significant difference between operation time for cases who underwent BDLUA and OBDL (p=0.085).

Complications (one hematoma, two infections, two deep vein thrombosis, and four dural injuries) were observed after surgical treatment in 9 patients who underwent BDLUA. Similarly, complications were observed in 13 patients who underwent OBDL (two hematomas, three infections, two increased transient motor deficits, one deep vein thrombosis, and five dural tears). There was no statistically significant difference between the two groups when complications after surgical treatment were evaluated (p=0.098).

Four patients who underwent BDLUA and who were followed up at 6 months postoperatively required fusion operation due to postoperative spondylolisthesis. Similarly, five patients who underwent OBDL required fusion operation for the same reason. The rates of spondylolisthesis after surgical treatment were similar between both groups, and there was no statistically significant difference (p=0.099).

The average hospital stay of the cases in the study who underwent BDLUA was 1.54±0.44 days, while the

average hospital stay of the patients who underwent OBDL was 3.72±1.02 days. There was a statistically significant difference between the two groups (p=0.032).

The mean blood waste was 78.3±23.4 ml in patients who underwent BDLUA and 183.7±72.4 ml in patients who underwent OBDL. When blood loss was evaluated, there was a statistically significant difference between the two groups (p=0.024) (Table 2).

Table 2. The comparison of the VAS score, walking times, complication, iatrogenic spondylolisthesis hospital stay, blood loss, and operation time in bilateral decompressive lumbar laminectomy with unilateral approach (BDLUA) and open bilateral lumbar laminectomy (OBDL) patients.

Variables	BDLUA Group n=(80)		OBDL Group n=(118)		
	Preoperative	Postoperative	Preoperative	Postoperative	p
VAS Score	62.06±4.48	26.81±4.74	61.12±4.85	23.06±7.50	0.21
Walking Times	21±3.4min	58±4.8min	19±3.2min	56±5.3min	0.33
Complication		9		13	0.098
İatrogenic Spondylolisthesis		4		5	0.099
Hospital Stay		1.54±0.44day		3.72±1.02day	0.032*
Blood Loss		78.3±23.4ml		183.7±72.4ml	0.024*
Operation Time		117±19.4min		112±17.2 min	0.085

***p < 0.05, statistically significant**

DISCUSSION

Although non-surgical treatments such as transforaminal steroid injection are used in the treatment of lumbar spinal stenosis (Weinstein et al., 2010), previous research has consistently shown that surgery is more effective than non-operative care for patients with LSS (Weinstein et al., 2008; Deyo et al., 2010). Over the years, various surgical techniques have been used, including BDLUA and OBDL.

OBDL involves removing the spinous process, interspinous ligament, and supraspinous ligament, which provides a large working area and good visibility. However, this procedure may lead to postoperative instability (Borshchenko et al., 2019). On the other hand, some authors agree that the BDLUA requires less muscle splitting and preserves the midline tissues, reducing postoperative discomfort and maintaining the stability of the lumbar spine (Papavero et al., 2009; Çavuşoğlu et al., 2007b). Maintaining the average power balance of the lumbar spine while achieving adequate decompression is a challenge in LSS surgery. Extensive facetectomy combined with extensive laminectomy may provide adequate decompression but may compromise mechanical stability and lead to iatrogenic instability. However, our study found no significant difference in the incidence of iatrogenic spondylolisthesis between the BDLUA and OBDL groups, suggesting that both techniques can decompress without compromising stability.

Previous research has demonstrated that a BDLUA can improve VAS scores, with the mean follow-up ranging from 7 months to 5.4 years (Çavuşoğlu et al., 2007a; Costa et al., 2007). In a study by Liu et al., the two-year follow-up results revealed no significant difference in VAS scores for leg pain between the two groups at 6 and 12 months (Liu et al., 2013). Similarly, we found no statistically significant difference between the two groups in improving visual analog scale (VAS) scores measuring leg pain intensity. This suggests that both techniques are equally effective in relieving pain.

The assessment of walking time plays a crucial role in the clinical evaluation of patients with LSS. Neurogenic claudication can worsen over time and cause severe disability and reduced quality of life. In a literature review comparing the outcomes of posterior decompression techniques, no significant difference was found between BDLUA and OBDL regarding walking durations (Overdevest et al., 2015). Our study was also consistent with the literature in this regard. The mean walking time of patients who underwent BDLUA was increased from 21±3.4 minutes before surgery to 58±4.8 minutes after surgery. Similarly, in the study of patients who underwent OBDL, the mean walking time increased from 19±3.2 minutes before surgery to 56±5.3 minutes after surgery. There was no statistically significant difference between the two groups when walking times before and after surgical treatment were evaluated (p > 0.05).

Length of hospital stays and delayed recovery can lead to more postoperative problems, such as blood clots, infections, heart and lung issues, blood clots in the lungs, bowel obstruction, and long-term narcotic use. These problems can also increase the cost of care (Armin et al., 2008; Jayarao & Chin, 2010; Khoo & Fessler, 2002). In a study by Mobbs et al., patients in the BDLUA group have significantly shorter average mobilization time and average postoperative hospital stay duration than those in the OBDL group (Mobbs et al., 2014). Similarly, we found that patients who underwent BDLUA had significantly shorter hospital

stays than those who underwent OBDL. This suggests that the unilateral approach may lead to faster recovery and reduced healthcare costs.

Blood loss during surgery is another important consideration, as significant blood loss may require transfusion and can have complications. Previous studies have shown that BDLUA has less intraoperative blood loss than OBDL (Kayalar et al., 2019; Yaman et al., 2015). This study found that patients with BDLUA experienced significantly lower blood loss than those who underwent OBDL. This indicates that the unilateral approach may be a safer option with reduced blood loss and potential transfusion requirements.

Complications are a critical factor to consider in any surgical procedure, and dural tears are commonly reported in surgeries for lumbar spinal stenosis. A recent systematic review conducted by Fourney et al. (2010) indicates that the current literature does not support the notion that less invasive lumbar surgery for posterior lumbar decompression reduces the incidence of complications, such as reoperation, dural tears, cerebrospinal fluid leaks, nerve injuries, and infections when compared to open techniques. In our study, 4 cases of durotomy were observed in the group that underwent BDLUA, while 5 cases of durotomy were observed in the group that underwent OBDL, which were primarily repaired. However, 3 patients who had a durotomy had previously received lumbar epidural steroid injections, which may have caused the dura to adhere to the flavum above it. This could be due to multiple attempts to locate the epidural space, which increases the risk of epidural scarring and fibrosis. Therefore, when evaluating patients for spinal decompression surgery, the surgeon should check for a history of previous epidural steroid injections and be extra cautious when removing the flavum from the dura. Our study found no significant difference in the incidence of dural tears between the two groups. Moreover, the two techniques had similar complications, such as infection, hematoma, deep vein thrombosis, and temporary motor deficit.

One of the potential drawbacks of BDLUA is that it may require a significant amount of time to become proficient due to its challenging learning curve (Parikh et al., 2008). Operation time is essential in neurosurgical practice, as longer surgical times can increase costs and potentially lead to more complications. However, our study showed no significant difference in surgery time rates between cases treated with BDLUA and those treated with OBDL techniques. This may be attributed to the fact that the procedures in this study were performed by a single surgeon with advanced experience using both BDLUA and OBDL techniques, thus resulting in a shorter learning curve for BDLUA.

Limitations of study

There are several limitations to our research. Firstly, our study only included a few patients from a single center. Secondly, the indications for the surgical technique were limited to lumbar spinal stenosis. Further research with more extended follow-up periods and larger sample sets is required to confirm the current findings.

CONCLUSION

In conclusion, our study shows that both bilateral decompressive lumbar laminectomy via unilateral approach and open bilateral lumbar laminectomy are effective surgical techniques for LSS. Patients treated with a BDLUA and OBDL had similar results regarding operative complications, VAS scores, walking time, operation time, and iatrogenic spondylolisthesis rates at follow-up. However, the duration of hospitalization and the quantity of intraoperative blood waste were significantly shorter in patients treated with the unilateral approach. Surgeons should consider these factors when choosing the most appropriate technique for each patient.

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Conflict of Interest

The author declares no potential conflicts of interest concerning this article's research, authorship, and/or publication.

Author Contributions

Plan, design: UA, BG; **Material, methods and data collection:**UA, SK; **Data analysis and comments:** UA, BG, SK, ACK ; **Writing and corrections:**UA, ACK.

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