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BILATERAL DECOMPRESSION BY UNILATERAL LAMINOTOMY AS AN EFFECTIVE METHOD FOR THE TREATMENT OF LUMBAR DEGENERATIVE SPINAL STENOSIS

LOMBER DEJENERATİF DAR KANAL OLGULARINDA ETKİLİ BİR YÖNTEM OLARAK UNİLATERAL LAMİNOTOMİ İLE BİLATERAL DEKOMPRESYON UYGULAMASI

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SUMMARY

A variety of techniques have been used for the treatment of degenerative lumbar spinal stenosis (DLSS). For most patients, the clinical outcomes are adversely affected by concomitant systemic diseases and destabilizing decompressive surgical approaches. Here, we present cases treated with lumbar decompression by unilateral laminotomy. A retrospective study was conducted of data obtained in a consecutive series of 18 patients treated with bilateral decompression by a unilateral laminotomy technique for DLSS over a three-year period (2009–2011). The preoperative and postoperative clinical and radiological evaluations were compared. One patient died due to myocardial infarction, and regular follow-up could only be achieved for 12 of the remaining 17 patients, eight women and four men. The mean follow-up period was 18.9 months and the mean age was 62 (52–76) years. The preoperative and postoperative mean AP diameter of the spinal canal was 8.26 (5–11) mm and 16.58 (10–30) mm, respectively ($p \leq 0.05$), the preoperative and postoperative transverse diameter was 6.69 (5–7.5) mm and 10.2 (8–14) mm, respectively ($p \leq 0.05$), and the preoperative and postoperative mean width of the facet joint gap was 3.18 (2–4) mm and 3.11 (2–4) mm, respectively ($p \geq 0.05$). The preoperative VAS score was 8.41 (7–10), and the Prolo functional score was 2 and the economic score was 2.6, while the postoperative values were 3.91 (0–8) ($p \leq 0.05$), 3.58 ($p \leq 0.05$), and 4.8 ($p \leq 0.05$), respectively. None of the patients required secondary surgery. During the restabilization period of the degenerative process, the unilateral laminotomy technique provided adequate canal decompression and achieved good clinical outcomes. With this surgical technique, the preservation of vertebral stability avoids the complications associated with the more aggressive implantation procedures.

Keywords: Spine; Lumbar; Spinal Stenosis, Surgery

Level of Evidence: Retrospective clinical study, Level IIIv

ÖZET

Dejeneratif Lomber Dar Kanal (DLDK) sendromunun tedavisi için birçok cerrahi yöntem kullanılmıştır. DLDK olgularının birçoğunda ek sistemik hastalıklarının bulunması ve standart dekompresif yaklaşımların ameliyat sonrası instabiliteye yol açması olasılığı nedeniyle klinik sonuçlar olumsuz etkilenmektedir. Çalışmamızda tek taraftan unilateral laminotomi yoluyla bilateral dekompresyon yapılmış olgular sunulmuştur. Kliniğimizde 2009–2011 döneminde DLDK tanısı konmuş ve unilateral laminotomi yoluyla bilateral dekompresyon yapılmış 18 olgu geriye dönük olarak incelenmiştir. Olguların ameliyat öncesi ve kontrol muayenelerinde klinik ve radyolojik incelemeleri karşılaştırılmıştır. Bir olgu izlemde miyokard infarktüsü nedeni ile kaybedilmiş, kalan 17 olgudan ancak 12 olguda düzenli takip sağlanabilmiştir. Ortalama izlem süresi 18,9 (4-36) aydır. Olguların 8'i kadın, 4'ü erkek, yaş ortalaması 62(52-76) yıldır. Ameliyat öncesi lomber spinal kanal ön-arka çap ortalaması 8,26 (5-11) mm, transvers çap 6,69 (5-7,5) mm, faset eklem aralığı ortalaması 3,18 (2-4) mm saptanmıştır. Ameliyat öncesi VAS 8,41 (7-10) puan, Prolo fonksiyonel skoru 2, ekonomik skoru 2,6 bulunmuştur. Ameliyat sonrası ön-arka çap 16,58 (10-30) mm [$p \leq 0,05$], transvers çap 10,2 (8-14) mm [$p \leq 0,05$], faset eklem aralığı 3,11 (2-4) mm [$p \geq 0,05$] bulunmuştur. Ameliyat sonrası VAS 3,91 (0-8) puan [$p \leq 0,05$], Prolo fonksiyonel skoru 3,58 [$p \leq 0,05$], ekonomik skoru 4,8 [$p \leq 0,05$] bulunmuştur. İzlem süresince hiçbir olguya ikinci operasyon gerekmemiştir. Dejeneratif sürecin restabilizasyon evresinde unilateral laminotomi yoluyla bilateral dekompresyon uygulanmış olgularda yeterli kanal genişliği sağlanarak olumlu sonuçlar alınmaktadır. Omurga destabilize edilmeksizin uygulanan bu yöntemde implantasyonun getireceği komplikasyonlardan kaçınılabilmektedir.

Anahtar Kelimeler: Omurga, Lomber, Dar kanal, Cerrahi

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

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INTRODUCTION

Degenerative lumbar spinal stenosis (DLSS) is a clinical situation in which factors such as facet joint hypertrophy, ligamentous hypertrophy, disc protrusion and spondylolisthesis decrease the central spinal canal, nerve root canal or interforaminal width below a critical value, together or individually[13]. Consideration of the developmental period of these factors shows that DLSS emerges at advanced ages.

Although there are many defined surgical methods for DLSS treatment, their success rates remain between 60–75%[10]. In addition to extra diseases found at advanced ages and a decrease in the balance potential of an elderly body, surgical methods such as decompressive total laminectomy, which are aggressive and have negative effects on spine biomechanics, decrease the success rate. Therefore, decompression, with a lesser effect on the spine anatomical structures and without instability, reduces the complication risk. Young et al. in 1988, followed by McCulloch et al., used a bilateral compression technique with unilateral laminotomy in order to limit destabilization by preserving the posterior tension band of the facet joints and opposite neural arch[4,24]. In this study, bilateral compression with unilateral laminotomy was applied to cases of DLSS, and the results were evaluated retrospectively.

MATERIALS AND METHODS

In this study, 18 cases diagnosed with degenerative lumbar spinal stenosis and treated with bilateral compression by unilateral laminotomy between 2009 and 2011 were evaluated retrospectively. The preoperative clinical status, last follow-up and radiological images were evaluated in detail. Surgeries for all cases were performed by a single surgeon (AD). One patient died due to myocardial infarction, and regular follow-up could only be achieved in 12 cases. The mean follow-up period was 18.9 (4–36) months. The cases included eight females and four males. The mean age of the cases was 62 (52–76) years. When patient complaints were considered, there was lower back pain in all patients, leg pain in 11 cases, neurogenic claudication in eight cases and loss of strength in three cases (Table-1). In radiological evaluations, lumbar spinal stenosis was detected in the L4–5 space of two cases, the L3–4 and L4–5 spaces in six cases, the L2–3, L3–4 and L4–5 spaces in one case, and the L3–4, L4–5 and L5–S1 spaces in three cases (Figure-1).

Figure-1. (A) Spinal stenosis image with preoperative T2-weighted sagittal section MRI. **(B)** Postoperative T1-weighted sagittal section MRI of the same patient.

In preoperative neurological examinations, straight leg raising tests were positive for three cases. Loss of motor strength was detected in seven cases.

Table-1. Demographic properties of the cases.

Follow-up period	Age	Gender (F/M)	Symptom Distance					
			Claudication	pain	Loss of strength	one	pair	Multilevel
18.9 (4–36)	62 (52–76)	8/4	8	12	3	2	6	4

Hypoesthesia was detected in four cases. In four cases, there was neurogenic claudication with no findings on neurological examination.

The clinical statuses of the cases were quantitatively defined with the visual pain scale. Similarly, the social lives and work activities of the patients were measured using Prolo scores

In lumbar vertebral CT examinations of all patients that were routinely taken preoperatively, the spinal canal antero–posterior transverse diameters and facet joint distances were measured. These measurements were repeated with CT in postoperative follow-up. In addition to bone structure, MRI was used to examine whether sufficient neural decompression was present in terms of the soft tissues in the spinal canal. Moreover, the stability development was examined by taking lumbar static and dynamic X-rays in the follow-up evaluations.

SURGICAL METHOD

The cases were operated on under general anesthesia in a prone position. The site with leg pain was chosen as the surgical site, and if there was no leg pain then the site with more neural decompression was chosen. All surgeries were performed microscopically. After unilateral laminotomy performed with the assistance of a high-speed drill, the spinous process base was expanded with a high-speed drill and the assistance of Kerrison rongeurs. The operating table was angled to the opposite site, the contralateral inferior facet joint extruded, and the adjacent nerve root canal was expanded by drilling. Therefore, the lateral and rostral borders of the ligamentum flavum were revealed bilaterally, and they were removed from the dura using cotton pads and excised. After completion of flavectomy, foraminotomy was carried out by revealing the bilateral nerve roots, and the roots were relaxed. There was no need for total facetectomy in any of the cases. In all cases, the spinous processes were preserved and the interspinous and supraspinous ligaments remained intact, in addition to the posterior tension band. No instability was observed and no stabilization was required during the early period or postoperative follow-up (Figure-2,3).

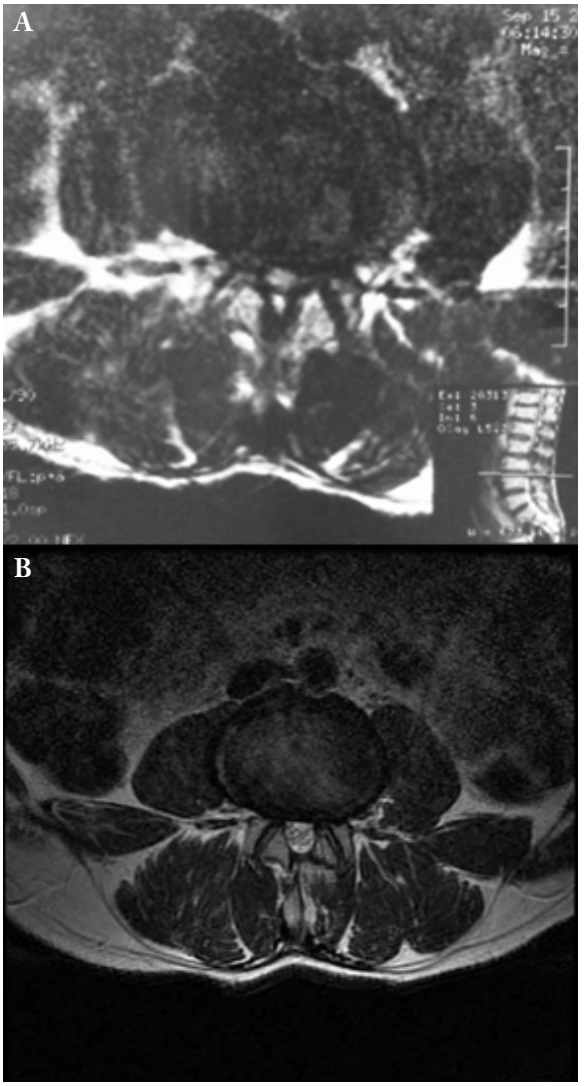

Figure-2. (A) Spinal stenosis seen with a preoperative T2-weighted axial section MRI. **(B)** Postoperative T2-weighted axial section MRI of the same patient.

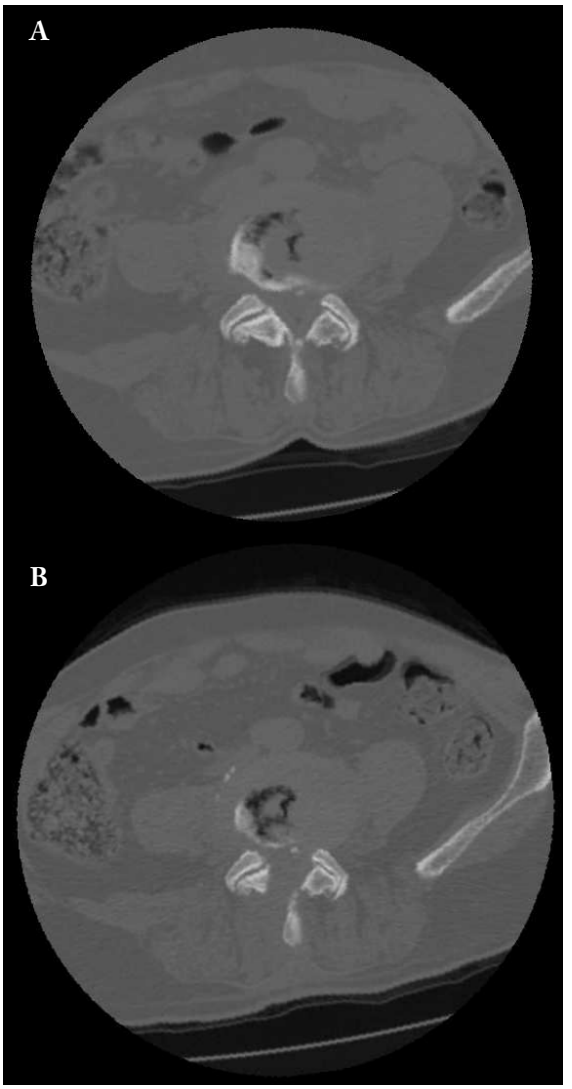

Figure-3. (A) Spinal stenosis image in preoperative axial section lumbar CT. **(B)** Postoperative axial section lumbar CT image of the same patient.

RESULTS

Preoperatively, the mean lumbar spinal canal antero-posterior diameter was 8.26 (5–11) mm, the mean transverse diameter was 6.69 (5–7.5) mm, and the mean facet joint distance was 3.18 (2–4) mm. The preoperative VAS score was 8.41 (7–10), and the Prolo functional score was 2 and the economic score was 2.6. The distributions of distances that received decompression were the L4–5 space in two cases, the L3–4 and L4–5 spaces in six cases, the L2–3, L3–4 and L4–5 spaces in one case, and the L3–4, L4–5 and L5–S1 spaces in three cases. Decompression was performed 12 times to the L4–5 space, ten times to the L3–4 space, three times to the L5–S1 space and once to the L2–3 space, independently of the distances that received decompression (Table-2).

Table-2. The distributions of the cases that received bilateral decompression by a unilateral approach according to distance.

Distance Distribution	n (%)
L2–3	1 (4%)
L3–4	10 (38%)
L4–5	12 (46%)
L5–S1	3 (12%)

Of the 12 cases that received bilateral decompression by unilateral laminotomy due to degenerative lumbar spinal stenosis, decompression was applied to the L4–5 level in two cases, the L3–4 and L4–5 levels in six cases, and three or more locations were decompressed in four cases. In the measurements carried out after surgery and during the follow-up, the mean lumbar canal antero-posterior diameter was 16.58 mm (10–30 mm; p≤0.05), the mean transverse diameter was 10.2 mm (8–14 mm; p≤0.05) and the mean facet joint range was 3.11 mm (2–4 mm; p≥0.05) for the decompressed areas. After surgery, the mean VAS value was 3.91 (0–8; p≤0.05), the Prolo functional score was 3.58 (p≤0.05), and the economic score was 4.8 (p≤0.05) (Table-3).

DISCUSSION

Degenerative lumbar spinal stenosis is a disease that causes pain and neurological deficit and develops by a chronic process, so it is mostly seen in older people. The degenerative process in the lumbar spine occurs in three phases, dysfunction, instability and stabilization.

It results in facet hypertrophy, osteophyte formation and a decrease in movement of functional segments due to loss of water in the disc and intradiscal collagen, which increases the stabilization phase. Neurogenic claudication, one of the clinical symptoms of spinal stenosis, becomes apparent in this period.

Decompressive laminectomy is the standard surgical method for DLSS treatment[3]. However, it has been shown that only 64% of patients benefit from this method, even in the best studies[8]. It is known that instability that develops due to changes in the spinal anatomy after large posterior compression leads to surgical failure[7,9,18,23]. Aryanpur and Ducker also suggested that total decompression could not provide symptomatic relief[4].

Table-3. The canal measurements and life quality of the cases, pre- and postoperatively.

	preoperative	postoperative	
Anteroposterior diameter	8.26 (5–11)	16.58 (10–30)	p≤0.05
Transverse diameter	6.69 (5–7.5)	10.2 (8–14)	p≤0.05
VAS	8.41 (7–10)	3.91 (0–8)	p≤0.05
PROLO (Function score)	2	3.58	p≤0.05
PROLO (Economic Score)	2,6	4.8	p≤0.05
Facet joint distance	3.18 (2–4)	3.11 (2–4)	p≤0.05

Abbreviations: *VAS= Visual analogue scale*

It is known that removal of more than 50% of the bilateral facet joints leads to instability, which dramatically increases lumbar implantation and fusion surgery[2,5].

In recent years, long-term follow-up of fusion surgeries has shown that degeneration is accelerated in adjacent segments[16]. Biomechanical changes triggering each other in a domino effect prevent the expected long-term symptomatic relief of patients. In addition, the wound stays open longer, due to the standard long period of decompression and instrumentation, and the infection risk increases. In patients with advanced age, co-morbid factors such as osteoporosis, coronary heart disease, diabetes and obesity increase this complication[12].

To perform standard lumbar decompressive laminectomy, the paraspinal muscle groups need to be retracted and their tendons need to be cut. In patients who received this surgery, Mayer et al. showed atrophy in the paraspinal muscles in postoperative CT images[14]. Complaints such as lower back pain affect the clinical results in these patients. During surgery, it was stated that cutting the supraspinous and interspinous ligaments could lead to spinal instability by destroying the flexion stability of the posterior tension band[15,21]. In addition, it is known that protection of the supraspinous and interspinous ligaments with the facet capsular ligament is important to provide flexion strength[1,5]. In a study by Hindle et al., they demonstrated that the supraspinous and interspinous ligaments provided stability in the spinal flexion phase[11,22]. In dynamic X-rays taken during follow-up, no instability development was observed. No damage was caused in any of the patients to their supraspinous or interspinous ligaments and their facet joints were preserved, and no instability was observed during postoperative follow-up.

Moreover, removal of the ligamentum flavum after laminotomy increases the possibility of dural damage during bone arch expansion. Therefore, performing flavectomy after expansion of the bone arch decreases the complication risk related to cerebrospinal fluid and nerve roots.

On the application of bilateral decompression with unilateral laminotomy, damage of the neural arch is minimized by minimizing bone resection. Similarly, the opposite muscle mass is protected due to the unilateral approach, and the patients' lower back pain and need for analgesics is reduced.

The definition of degenerative lumbar absolute spinal stenosis is a lower lumbar spinal canal diameter of less than 10 mm. However, there have been articles suggesting that evaluation of the canal diameter area is more accurate. If the spinal canal area is lower than 104 mm2 in the L2–3 space, 88 mm2 in the L3–4 space, or 44 mm2 in the L4–5 space, symptomatic or asymptomatic lumbar spinal stenosis can be present[17]. In the studies, it has been reported that both laminotomy and laminectomy provide a significant increase in the dural sac width compared with preoperative measurements, and there were no statistically significant differences between the two groups in terms of clinical results[6,19,20]. Among the cases that received bilateral and unilateral hemilaminotomy, although there was a statistical difference in terms of the dural sac width, the clinical results of the two groups were found to be similar, and it was reported that unilateral hemilaminotomy provided symptomatic relief in patients by increasing the dural sac area[24].

In addition to providing bilateral decompression with unilateral laminotomy, opposite nerve root decompression can be also performed. Therefore, contralateral radicular findings that can occur during the follow-up can be prevented. However, we think that bilateral laminotomy is more suitable for patients with degenerative lumbar stenosis in the L1–2 and L2–3 spaces, as the conus is located in these regions, and therefore is at risk of being damaged.

CONCLUSION

In DLSS patients, sufficient canal width is provided by bilateral decompression with unilateral laminotomy, and the instability risk is minimized as the supraspinous and interspinous ligaments and facet joints are preserved. Therefore, we think that possible complications due to instrumentation are reduced, the healing period after surgery is shorter, and positive clinical results can be obtained with this technique.

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