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Research

Efficacy and Safety of Microscopic Bilateral Decompression with Unilateral Laminectomy in Geriatric Lumbar Spinal Stenosis Surgery

Lomber Spinal Stenoz Cerrahisinde Unilateral Laminektomi ile Bilateral Dekompresyon Yaklaşımının Yaşlı Hastalarda Etkinlik ve Güvenilirliği

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ABSTRACT

Objective: To evaluate the efficacy and reliability of microscopic bilateral decompression with unilateral laminectomy in geriatric lumbar spinal stenosis (LSS) patients and to compare the results with the younger patients.

Methods: LSS patients who underwent micro-bilateral decompression with a unilateral approach (BiDUA) between May 2015 and June 2019 at (blinded) were retrospectively reviewed. Patients demographic characteristics, pre- and postoperative clinical and radiological features, pain scores and surgical details were evaluated. They were also grouped according to their age to compare the surgical efficacy and reliability in different age groups.

Results: Fifty seven patients were included in our study. There were 28 males and 29 females. Mean age was 65.75±8.96 (46-82). Thirty one (54.4%) patients were 66 years or older. All patients complained of lower back pain and exhibited neurogenic claudication. Twenty nine patients (50.9%) received single-level, whereas 28 patients (49.1%) required double-level surgery. All patients's neurogenic claudication-improved postsurgery. Nine patients experienced postoperative complications (5 dural injuries, 3 superficial wound infections and 1 cerebrospinal fluid fistula). There were statistically significant differences in both back pain and leg pain following surgery. However, there were no statistically significant differences in either visual analog scale back pain or leg pain scores between the age groups.

Conclusion: Although the surgical treatment of LSS involves greater risks in elderly patients, we found no statistically significant difference in the complication rate between age groups following micro-BiDUA, which supports the efficacy and safety of micro-BiDUA for elderly patients.

Keywords: Lumbar stenosis, bilateral decompression with unilateral approach, microsurgery, neurogenic claudication, minimally invasive spine surgery

ÖZ

Amaç: Mikroskobik unilateral laminektomi ile bilateral dekompresyonun geriatrik lomber dar kanal (LSS) hastaların tedavisindeki güvenilirliği ve etkinliğinin araştırılması ve sonuçların genç hastalar ile kıyaslanmasıdır.

Gereç ve Yöntem: Mayıs 2015 ve Haziran 2019 arasında (blinded) mikroskobik unilateral laminektomi ile bilateral dekompresyon (BiDUA) uygulanan LSS hastaları retrospektif olarak incelendi. Hastaların demografik özellikleri, pre ve postoperatif klinik ve radyolojik özellikleri, ağrı skorları ve cerrahi detayları araştırıldı. Hastalar aynı zamanda yaşlarına göre gruplandırılarak farklı yaş grupları arasındaki cerrahi etkinlik seviyeleri karşılaştırıldı.

Bulgular: Çalışmaya dahil edilen 57 hastanın 28'i erkek 29'u kadındı. Ortalama yaş 65,75±8,96 (46-82) olarak hesaplandı. Otuz bir (%54,4) hasta 66 yaş ve üzeriydi. Tüm hastaların bel ağrısı ve nörojenik kladikasyosu mevcuttu. Yirmi dokuz hasta (%50,9) tek seviye, 28 hasta (%49,1) çift seviye nedeniyle opere edildi. Tüm hastaların nörojenik kladikasyosunun ameliyat sonrasında düzeldiği izlendi. Dokuz hastada komplikasyon gelişti (5 dura yaralanması, 3 yüzeyel yara yeri enfeksiyonu ve 1 beyin omurilik sıvısı fistülü). Ameliyat sonrası dönemde hastaların hem bel hem de bacak

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ağrısında istatistiksel olarak anlamlı azalma izlendi. Ancak yaş grupları arasında bel ve bacak ağrısı için belirtilmiş vizüel analog skala skorları karşılaştırıldığında, anlamlı sonuca ulaşılamadı.

Sonuç: LSS cerrahisi yaşı hastalarda daha fazla risk içerse de mikroskobik unilateral laminektomi ile bilateral dekompresyonun komplikasyon oranlarının farklı yaş grupları arasında değişmediği gösterilmiştir. Bu sonuç geriatrik popülasyonda tekniğin güvenilirliği ve etkinliğini desteklemektedir.

Anahtar Kelimeler: Lomber dar kanal, mikroskobik unilateral laminektomi ile bilateral dekompresyon, mikrocerrahi, nörojenik kladikasyon, minimal invaziv spinal cerrahi

INTRODUCTION

Lumbar spinal stenosis (LSS) is defined as narrowing of the spinal canal due to the hypertrophic changes of soft tissues, bony structure, lateral recesses, and (or) neural foramina. It usually develops because of facet and intervertebral joint degeneration, thickening of ligamentous structures, or protrusion of the nucleus pulposus (1). In 1949, Verbiest described the clinical relationship between LSS and neurogenic claudication and LSS with claudication is currently one of the most common indications of spinal surgery due to the growing geriatric population and expectations of sustained quality of life in the old age (2-4).

Shortened walking distance, neurological deficits, restricted daily activity, and failure of conservative treatment are common indications for the surgical treatment of LSS. Total laminectomy combined with medial facetectomy and foraminotomy is recognized as the gold standard in LSS surgery. However, long operation time, excessive tissue damage and bleeding, high risk of mortality and morbidity, and instability following LSS surgery have led surgeons to consider alternative surgical techniques, particularly for the elderly, who are also most vulnerable to these complications. In the recent years, operating microscopes and endoscopes have facilitated the greater use of minimally invasive spinal surgical (MISS) techniques for LSS treatment. The primary goals of these MISS approaches are to reduce tissue damage, speed up recovery time, reduce postoperative pain and complication rates, lower blood loss, prevent instability and allow an early return to daily activities. One MISS technique known to be effective for LSS is bilateral decompression with a unilateral approach (BiDUA), which can be performed under either microscope guidance (micro-BiDUA) or endoscope guidance (endo-BiDUA). Micro-BiDUA was first described by Poletti (5) in 1995 and modified by McCulloch and Young (6) in 1998. In this technique, the dural sac and bilateral nerve roots are decompressed by resection of the contralateral ligamentum flavum from the arc inferior, while preserving the supra- and interspinous ligament complex and the contralateral paraspinal muscles and facet joints (7). Based on the previously published studies, Shamji et al. (8) concluded that MISS procedures are safe and effective for elderly LSS patients and Wada et al. (9) reported that endo-BiDUA was superior to traditional laminectomy.

Wada et al. (9) also compared micro-to endo-BiDUA and found various advantages and disadvantages to each procedure. In this study, we evaluated the efficacy and reliability of micro-BiDUA for geriatric LSS. We hypothesize that the short-term efficacy and complication rates of the micro-BiDUA approach for geriatric patients (older than 65 years) would be equivalent to that for younger patients.

METHODS

Patient Selection

Consecutive LSS patients who received micro-BiDUA between May 2015 and June 2019 (blinded) were considered candidates for this study. Inclusion criteria were radiologically diagnosed LSS by magnetic resonance imaging (MRI) and computed tomography (CT), neurogenic claudication with or without radiculopathy, and nonresponse to conservative treatment for more than three months. Patients who had undergone lumbar fusion for LSS and patients with significant instability due to disk herniation, spinal malignancy, or infection were excluded.

All surgical interventions were performed by a single surgeon (G.G.) to minimize variability. All patients received preoperative physical and neurological examination, lumbar MRI, and CT as well as postoperative lumbar CT. In addition to demographic data, clinical variables such as comorbidities, preoperative American Society of Anesthesiologists (ASA) Physical Status classification, duration of surgery, bleeding volume, surgical level (single- or double-level among L3-4, L4-5, and L5-S1), duration of hospitalization, complication rates, patient satisfaction, and pain scores were assessed. Pain levels were scored from zero to ten using a visual analog scale (VAS) in which zero means no pain and ten means the worst pain imaginable. VAS scores were recorded immediately after surgery and during the first, sixth and twelfth month postoperatively (10).

Patients were subgroups according to the severity of neurogenic claudication (1: 0-50 meters; 2: 50-250 meters; 3: 250-1000 meters; 4: over 1000 meters) both preoperatively and at 12 months post-surgery. Patient satisfaction was evaluated according to the MacNab classification at 12-month post-surgery as perfect (no pain, no disability to work), good (rare back of leg pain), moderate (occasional pain but cannot continue working), poor (continued pain need for second surgery) (11). Patients were also stratified by age into an older group (≥66 years) and a younger group (≤65 years) for comparison of surgical efficacy and reliability. Ethical approval for this study was obtained from University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Clinical Research Ethics Committee (decision no: 2021-17-07, date: 06.09.2021).

Surgical Method

Patients were placed in the prone position for marking of the relevant level under C-arm fluoroscopy guidance. A posterior midline incision was created, and the paravertebral thoracolumbar fascia was opened unilaterally at the planned level while preserving the functional and anatomical integrity of the contralateral muscles, supra- and interspinous ligaments, and the spinous protrusion of midline structures such as interspinous ligaments and thoracolumbar fascia. Paravertebral muscles were removed one-sided by subperiosteal stripping to expose the medial wall of the facet joint. Then, unilateral hemilaminectomy was performed under surgical microscopy. During hemilaminectomy, only the medial parts of the lamina-exerting pressure on the dural sac and nerve root were removed, while facet joints, which are crucial for spine stabilization, were preserved. The thickened ligamentum flavum was resected from the same side and foraminotomy was performed on the nerve roots compressed behind it. Simultaneously, the intervertebral disc space was monitored for disc fragments. Afterwards, the operating table and microscopy were tilted to an angle allowing a contralateral approach, and contralateral hemilaminectomy, flavectomy and foraminotomy were performed using a high-speed drill and Kerrison rongeurs. A transmedian unilateral approach was started at the inferior line of the midline where the spinous process bonds with the insertion line at the lamina. As the thickened ligamentum flavum was resected, pressure on the dural sac was relieved. Following the release of the thickened flavum, the contralateral side was expanded up to the axillary level of the foramen using Kerrison rongeurs. Bleeding and cerebrospinal fluid (CSF) leakage were checked after the contralateral foramen was checked with a nerve hook. Following hemostasis, a drainage tube was inserted in patients requiring surgery at multiple levels.

Statistical Analysis

SPSS version 18.0 was used for all statistical analyses. Numeric variables are presented as mean ± standard deviation, and categorical variables as a number of observations and percentages (%). Quantitative data were compared by student's t-test or Mann-Whitney U test as indicated, while 12-month postoperative results were compared to baseline conditions using the Mantel-Haenszel test. Back pain before and after surgery (postoperative 1st, 6th and 12th months) was compared by Wilcoxon-marked row tests.

RESULTS

Fifty-seven patients were enrolled in our study, of which 31 (54.4%) were aged 66 years or older and 26 (45.6%) were 65 years or younger. Mean age was 65.75±8.96 (46-82) and the cohort included roughly equal numbers of females and males (28, 49.1% vs. 29, 50.9%). All patients reported lower back and leg pain before surgery and substantial reductions post-surgery as measured by VAS scores (Table 1).

Before surgery, 10 patients (17.5%) exhibited neurogenic claudication between 0 and 50 meters and 47 (82.5%)

Table 1. Visual analog scale for back and leg pain before and after surgery

		VAS scores			
Pain locations		min	max	mean	SD
Lower back pain	Preoperative	7	9	7.9772	0.59971
	Postoperative 1st month	2	4	2.7544	0.71418
	Postoperative 6th month	1	4	2.1754	0.60127
	Postoperative 12th month	1	3	1.8947	0.55691
Leg pain	Preoperative	7	9	7.3684	0.55522
	Postoperative 1st month	1	5	2.3860	0.83995
	Postoperative 6th month	1	5	2.0175	0.81265
	Postoperative 12th month	1	5	1.9298	0.75261

SD: Standard deviation, VAS: Visual analog scale, min: Minimum, Max: Maximum approximately 51-250 meters, while 12 months post-surgery, only 4 (7%) demonstrated neurogenic claudication approximately 51-250 meters, with the remaining patients reporting pain between 250 and 1000 meters (18 patients, 31.6%) or above 1000 meters (35 patients, 61.4%). Before surgery, 39 patients (68.4%) were identified as ASA Physical Status grade I (healthy, lowest risk) and 18 (31.6%) as ASA-II (mild systemic disease). Of the total cohort, 57.9% were diagnosed with hypertension, 22.8% with chronic obstructive pulmonary disease (COPD), 21.1% with diabetes mellitus (DM), and 5.3% with congestive cardiac failure. A stroke history was present in 12.3% of the cases. mean duration of operation was 76.84±21.62 min (50-130 mins), average blood loss during surgery was 59.38±23.20 mL (25-120 mL), and the mean hospital stay was 2.49±2.23 days (1-15 days).

Twenty-nine patients (50.9%) received single-level surgery, 21 (36.84%) at L4-5 and 8 (14.03%) L3-4, while 28 (49.1%) required double level, 23 (40.35%) at L3-4 and L4-5 levels and 5 (8.77%) at L4-5 and L5-S1 levels. Neither preoperative nor 12-month postoperative claudication scores differed between patients requiring single-level or double-level surgery according to the Mantel-Haenszel test ($2\times2x^22=1.850$, $p=0.174$). Alternatively, the duration of the surgery and average blood loss were significantly higher among patients requiring double level surgery (operation duration: $2\times2x^22=33.403$, $p<0.001$; average blood loss: $2\times2x^22=36.285$, $p<0.001$) (Table 2 and 3). The duration of hospitalization was also significantly longer in the double-level surgery group. Among the comorbidities examined, only COPD was significantly associated with the time of hospitalization ($Z=2.07$ $p=0.04$).

Nine patients experienced postoperative complications (21.05%), including 5 cases of dural injury (8.85%), 3 of superficial wound infection (5.3%), and one case (1.7%) of CSF fistula (requiring reoperation for repair). Only four patients (7%) reported neuropathic pain postoperatively, and there were no postoperative neurological deficits. Of the 9 patients with complications, the majority were in the double-level subgroup (7 vs. 3) including all cases of dural tears, but the difference in the overall complication rate did not reach statistical significance ($2\times2x^22=0.295$ $p=0.148$).

There were statistically significant differences in both back pain and leg pain following surgery compared to baseline according to the Wilcoxon-marked row test (back pain: 1st month $Z=6.71$ $p<0.05$, 6th month $Z=6.74$ $p<0.05$, 12th month $z=6.69$ $p<0.05$; leg pain: 1st month $Z=6.74$ $p<0.05$, 6th month $z=6.66$ $p<0.05$, 12th month $Z=6.69$ $p<0.05$). Further, most patients reported good or perfect outcome according to the MacNab classification at 12 months post-surgery, and there was no difference in MacNab class distribution at 12-months post-surgery between patients requiring single- and double-level surgical correction ($2\times2x^22=0.893$, $p=0.345$) (Table 4 and 5). There was also no statistically significant difference in MacNab class distribution between patients with or without a comorbidity.

Finally, we compared baseline condition and postsurgical outcomes between patient subgrouped according to age (≤65 years and ≥66 years). The distribution of surgical sites differed between groups. In the younger subgroup, L4-5 was the most common level (11 patients, 42.3%), followed by L3-4 and L4-5 (9 patients, 34.61%), L3-4 (4 patients,

Table 2. Comparison of surgical duration between patients requiring single-level and double-level micro-BiDUA

		Surgical duration			Total
		30-60 min	61-90 min	91-130 min	
	Single level	18	11	0	29
	Double level	1	9	18	28
Total		19	20	18	57

micro-BiDUA: Micro-bilateral decompression with a unilateral approach

Table 3. Comparison of average blood loss between patients requiring single-level and double-level micro-BiDUA

		Average blood loss			Total
		1-50 mL	51-100 mL	101-150 mL	
	Single level	27	2	0	29
	Double level	3	24	1	28
Total		30	26	1	57

micro-BiDUA: Micro-bilateral decompression with a unilateral approach

15.38%), and L4-5 and L5-S1 (2 patients, 7.69%), while in the elderly subgroup, L3-4 and L4-5 were the most common (14 patients, 45.16%), followed by L4-5 (10 patients, 32.25%), L3-4 (4 patients, 12.9%) and L4-5 and L5-S1 (3 patients, 9.67%). Nonetheless, there were no statistically significant differences in either VAS back pain or leg pain scores between the groups at any postoperative time as evaluated by Mann-Whitney U test (back pain: 1^{st} month Z=1.38, p=0.17; 6^{th} month: Z=1.47, p=0.14; 12^{th} month: Z=0.59, p=0.56; leg pain: 1^{st} month Z=1.06, p=0.29; 6^{th} month Z=1.06, p=0.29; 12^{th} month Z=0.35, p=0.73). Furthermore: the distribution of MacNab classes at 12 months post-surgery, the duration of the operation, and neurogenic claudication distances did not differ between age groups (MacNab class: Z=0.43, p=0.66; duration of the operation: Z=0.75, p=0.45; preoperative neurogenic claudication distance: $2\times 2x^{2}2=1.19$, p=0.27; postoperative neurogenic claudication distance: $2\times 2x^{2}2=3.84$, p=0.14).

DISCUSSION

With population aging, there is a growing need for surgical procedures with greater efficacy and reduced complication risks in geriatric patients. Many studies have reported generally favorable outcomes using MISS techniques compared with traditional methods, including among geriatric patients (12,13). For instance, Giannadakis et al. (14) reported better patient satisfaction after micro-BiDUA than after open surgical intervention. In our study, as well, micro-BiDUA proved equally effective and safe for patients older than 65 compared to a younger subgroup, despite the more frequent need for multisegment intervention.

Table 4. Distribution of MacNab classifications at 12 months post-surgery

MacNab class	# of patients	%
Poor	1	1.8
Moderate	8	14
Good	33	57.9
Perfect	15	26.3
Total	57	100

Mean lower back and leg pain VAS scores were marked reduced post-surgery (7.87±0.599 and 7.36±0.555 at baseline vs. 1.89±0.556 and 1.92±0.752 12 months), indicating that the surgical outcome was generally successful. Indeed, patient satisfaction as evaluated by the MacNab classification was 84.2% (57.9% rated good and 26.3% as perfect) and did not differ between patients requiring single- or double-level surgery. Similarly, Hwang et al. (15) found substantial improvements in pain score one year after BiDUA (from 6.91±1.98 to 2.08±1.35) as well as high success rates for both low back pain reduction (83.8%) and leg pain reduction (86.3%) (15). Moreover, Oertel et al. (16) reported that VAS improvement was maintained for 4-10 years (6.91±1.98 before surgery to 2.44±1.60 after surgery). Costa et al. (17) also reported an average change in VAS score from 8.9 to 4.2 and a success rate of 87.9% for lower back pain reduction after 30.3 months of follow-up. However, overall results have varied across cohorts, as Yang et al. (18) reported a satisfaction rate of only 61.9% at 3 years post-surgery among patients of similar age to the current study (64.1±8.9 years).

Nevertheless, the BiDUA approach has demonstrated consistent success in older patients. Weiner et al. (7) reported an 87% reduction in pain at one year follow-up and Shabat et al. (19) reported a satisfaction rate of 76% in patients older than 80 years. Similarly, Hwang et al. (15) found no differences in VAS scores or claudication between younger and older age groups at an average follow-up of 6.5 months after BiDUA. Similarly, Ha et al. (20) found no difference in efficacy between 66 and 75 years and over 75 years age groups one year after BiDUA as measured by VAS scores and MacNab classification. Shamji et al. (21) also concluded that BiDUA is an effective and reliable method for elderly LSS patients.

Papavero et al. (22) reported reduced pain in 83.9% of cases after one-year follow-up and a 92.2% improvement in walking performance. In our study as well, neurogenic claudication distance was improved substantially after surgery. While no patient could walk 250 m without pain at baseline, 18 (31.6%) could walk 250-1000 meters and 35 patients (61.4%) over 1000 meters at one-year post-surgery. In support of similar

Table 5. Distribution of MacNab classifications in single- and double-level surgery cases

		MacNab values				Total
		Poor	Moderate	Good	Perfect	
	Single level	0	3	18	8	29
	Double level	1	5	15	7	28
Total		1	8	33	15	57

efficacy in geriatric patients, we found no differences in VAS scores and severe claudication rate between age groups one year after micro-BiDUA. Antoniadis reported that the cases-benefitting most the following surgery could walk less than 50 meters pain-free at baseline. This increased mobility will undoubtedly enhance patient quality of life (23).

The surgical duration was longer and blood loss was greater among patients requiring multilevel surgery. Nonetheless, all procedures were completed within 130 min and almost all patients lost less than 100-mL blood, underscoring the safety of this procedure. Following multiple level surgeries, routine drainage was introduced to achieve adequate bleeding conrol, which probably increased the duration of hospital stay compared to single-level surgeries (24). Shin et al. (25) found that level of preoperative functionality, presencec of DM, number of operated segments, and ASA grade III influenced mean hospitalization time. However, Tanaka et al. (26) found no difference in surgical success between single and multilevel surgeries if patient selection was conducted carefully. They also found significantly higher blood loss during multisegment surgeries but no difference in blood loss per level as well as longer surgical duration but a shorter duration per level (26). Conversely, Papavero et al. (22) found no differences in total operation time or average blood loss, indicating that BiDUA is a safe and effective method for multilevel LSS, even in high-risk patients. Deyo et al. (27) reported that mortality increased with age and was associated with the presence of comorbidities. However, we found no statistically significant difference in the MacNab classification distribution between patients with and without comorbidities.

Minimally invasive approaches have caused less severe tissue damage, fewer intraoperative complications, and lower blood loss, leading to shorter hospitalization. Ha et al. (20) reported an average hospitalization stay of 8 days after BiDUA and an average blood loss of only 30 mL. Further, surgical durations as short as 20 min, average blood loss of only 50 mL, and mean hospitalization times of only one or two days have been reported, although endocrinological or respiratory system diseases in addition to patient age may extend postoperative hospitalization (28,29). In this study, we found that only COPD had a statistically significant impact on hospitalization duration.

Dural injuries have been reported in 1.1%-12% of BiDUA cases. Similar to previous studies, dural injury was the most frequent complication in our cohort study (8.8%), all of which developed during multilevel surgeries (20,30). Alternatively, incidence did not differ between the age groups. In contrast to dural injury, CSF fistulas are relatively uncommon (incidence of 0%-1.5%) and the only such case was encountered in the current study, again during a multisegment operation (16,22,31). Apart from this case, revision surgery was not required during the early postoperative period. Moreover, no cases of instability or restenosis were encountered. Thus, the total complication rate was at the lower end of the range estimated by Deschuyffeleer et al. (32) across postoperative periods (0%-27%). However, our one-year follow-up is considered short-term. These complications reported after BiDUA may be explained by limited surgical space and difficulty seeing critical structures (29).

Because of the retrospective study design, important factors associated with outcome may have been excluded. Furthermore, the small sample size precluded a detailed comparison of specific complications between the age groups.

CONCLUSION

Although the surgical treatment of LSS involves greater risks in elderly patients, we found no statistically significant difference in the complication rate between age groups following micro-BiDUA. Our study therefore supports the efficacy and safety of micro-BiDUA in elderly patients. Additionally, patients reported high satisfaction even if multiple segments required surgical repair.

ETHICS

Ethics Committee Approval: Ethical approval for this study was obtained from University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Clinical Research Ethics Committee (decision no: 2021-17-07, date: 06.09.2021).

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: D.G.G., Concept: D.G.G., D.D., Design: D.G.G., D.D., Data Collection or Processing: D.G.G., D.D., Analysis or Interpretation: D.G.G., D.D., Literature Search: D.G.G., D.D., Writing: D.G.G., D.D.

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