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# Should Stabilization be Added to Decompression in Lumbar Spinal Stenosis Surgery?

# Lomber Spinal Stenoz Cerrahisinde Dekompresyona Stabilizasyon Eklenmeli Mi?

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**Öz**

Lomber spinal stenozun cerrahi tedavisinde sadece dekompresyon yapmak veya dekompresyona stabilizasyon eklemek seçenekleri hep bir tartışma konusu olmuştur. Biz de lomber spinal stenoz cerrahisinde dekompresyona stabilizasyon eklenmesinin klinik sonuçlara etkisini araştırmayı amaçladık. Altı yıl boyunca total laminektomi ile lomber stenoz ameliyatı geçiren hastalar klinik sonuçlar açısından değerlendirildi. Hasta memnuniyeti birincil başarı kriteri olarak kabul edildi. Tekrar ameliyat edilen hastalar cerrahi sonuçlardan memnun olduklarını belirtseler bile başarısız olarak değerlendirildiler. Çalışmaya toplam 73 hasta dahil edildi. Bir veya iki segment stabilizasyonu olan hastaların, hiç stabilize olmayanlara (p=0,019) göre daha tatmin edici sonuçlara sahip olduğu görüldü. Ancak üç veya daha fazla segment stabilizasyon grubu ile sadece laminektomi (p=1.0000) ve bir veya iki segment stabilizasyon (p=0.0667) grupları arasında başarı açısından fark yoktu. Ayrıca ameliyat sırasında dura yaralanması olmamasının (p=0.02148) başarıyı arttırdığı belirlendi. Bir veya iki seviyeli stabilizasyon ile lomber dekompresyonun, tek başına dekompresyon grubuna göre daha tatmin edici sonuçlara sahip olduğu bulundu. Ancak stabilize segment sayısı arttıkça bu farkın kaybolduğu göz önünde bulundurularak stabilizasyon endikasyonu dikkatle değerlendirilmeli ve stabilize segmentin gereksiz yere uzatılmaması için azami çaba gösterilmelidir. Stabilizasyonun etkilerinin daha fazla araştırılması için daha geniş hasta serileriyle yapılacak prospektif çalışmalar faydalı olacaktır.

**Anahtar Kelimeler:** Dekompresyon, Laminektomi, Lomber Vertebra, Spinal Stenoz, Stabilizasyon

**Abstract**

In the lumbar spinal stenosis surgery, the options of performing only decompression or adding stabilization to decompression have always been a matter of debate. We aimed to investigate the effect of adding stabilization to decompression on clinical outcomes in lumbar spinal stenosis surgery. Patients who underwent lumbar stenosis surgery with total laminectomy over six years were evaluated for clinical outcomes. Patient satisfaction was accepted as the primary success criterion. Patients who underwent reoperation were considered unsuccessful even if they stated that they were satisfied with the surgical results. A total of 73 patients were included in the study. Notably, patients who underwent stabilization of one or two spinal segments had more satisfying results than those without stabilization (p=0.0195). However, no significant differences in satisfaction were observed between patients with three or more stabilized segments and either the laminectomy-only group (p=1.0000) or the one-to-two segment stabilization group (p=0.0667). It was also determined that no dural injury during surgery (p=0.02148) increased success. Lumbar decompression with one- or two-level stabilization was found to have better satisfying results than the decompression-only group. However, considering that success decreases as the number of stabilized segments increases, the indication for stabilization should be carefully evaluated and maximum effort should be made to prevent unnecessary extension of the stabilized segment. Prospective studies with more extensive patient series will help investigate the effects of stabilization further.

**Keywords:** Decompression, Laminectomy, Lumbar Vertebrae, Spinal Stenosis, Stabilization

## Introduction

Lumbar spinal stenosis (LSS) is characterized by radicular pain and neurogenic claudication caused by compression of nerve elements due to narrowing of the spinal canal (1,2). Narrowing of the spinal canal is caused by bony and ligamentous hypertrophy, disc protrusion, spondylolisthesis, or their combination. Surgical decompression is generally accepted treatment for progressive lumbar spinal stenosis cases that do not respond to conservative treatment. Wide laminectomy and flavectomy at the stenotic levels are the standard procedures for the surgical decompression of LSS. However, the extensive removal of posterior spinal elements in advanced stenosis carries a significant risk of spinal instability. On the other hand, it may not always be possible to preserve the lateral half of facet joints and pars interarticularis. Post-decompression instability can be prevented with instrumented or non-instrumented spinal fusion (3).

Recently, surgical techniques involving minimal decompression, such as fenestration, laminotomy, laminoplasty, and split laminectomy, are increasingly used techniques to maintain post-decompression spinal stability and eliminate the need for fusion. Nevertheless, some studies reported higher restenosis rates with these minimal decompression techniques (4,5). While stabilization performed due to concerns of instability has advantages, it also has disadvantages, such as the possibility of causing complications like pseudoarthrosis and adjacent segment disease.

Decisions of adding stabilization to decompression surgery can be made on a case-by-

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case basis. This study investigates whether adding stabilization to decompression surgery in lumbar spinal stenosis affects clinical outcomes and, if so, in which subgroups it positively influences the clinical results.

## Material and Method

Approval was obtained from the local ethics committee for the study. Patients who underwent surgery due to LSS within six years at our hospital were identified from the surgical records. Patient information was retrieved from the hospital's Probel data recording system, and their images were examined from the hospital's PACS system. Additionally, images taken at other hospitals were accessed through the national e-Nabız data recording system if available.

Inclusion criteria:

a) At least one level of total laminectomy

b) At least six months follow up

Exclusion criteria:

a) Preoperative functional imaging proving lumbar instability

b) History of fracture or surgery at the laminectomy levels

c) Syndromic patients (achondroplasia, etc.)

All patients who met the above-mentioned criteria and whose records were accessible were included in the study. Patients included in the study were called for polyclinic control. Face-to-face patient satisfaction and Roland Morris Disability Questionnaire (RMDQ) surveys were conducted for those who could attend clinic follow-up, and telephone surveys were conducted for those who could not. In addition, the presence of neurogenic claudication was questioned. Preoperative independent variables were gender, age, height, weight, body mass index (BMI), walking distance, and degenerative spondylolisthesis. Perioperative independent variables were the number of stabilized segments and total laminectomies, dural injury, blood usage, and length of the surgery. Dependent variables included success (reoperation/satisfaction), RMDQ, and postoperative neurogenic claudication. Patient satisfaction was divided into three groups: satisfied, unsure and unsatisfied. For surgical outcomes, patients who did not explicitly state their satisfaction (the sum of those who said they were unhappy and those who were unsure) were considered unsuccessful. Even if the patient was satisfied with their current state, the initial surgery was deemed unsuccessful if they had reoperation due to lumbar spinal stenosis. Patients who underwent lumbar spinal stenosis surgery only once and explicitly stated their satisfaction was considered successful. Neurogenic claudication was defined as the patient being able to walk less than 1000 meters before needing to sit down. Outcomes of cases that received only decompressive laminectomy were compared with those of stabilization-added ones.

*Statistical analysis*

Power analyses were conducted to evaluate the test power for a sample size of 73 using both medium and large effect sizes. According to the post-power analysis, statistical power was obtained as 0.727 and 0.908, for a medium effect size (Cohen's w=0.3) and large effect size (Cohen's w=0.5) respectively, both with a type 1 error of 0.05. Then the numerical data for 73 patients were initially examined for minimum, maximum, mean, and standard deviation values. Subsequently, the Shapiro-Wilk Normality Test was used to analyze whether the numerical variables followed a normal distribution. Variables found to be normally distributed were analyzed in subsequent steps using the parametric test ANOVA. While comparing numerical variables to each other, Spearman's Rank Correlation analysis was used to examine whether there is an association between continuous variables. For variables that did not follow a normal distribution, non-parametric tests such as the Mann-Whitney U Test and Kruskal-Wallis Rank Sum Test were used. Specifically, the Mann-Whitney U Test was applied for variables with two groups, while the Kruskal-Wallis Rank Sum Test was used for variables with three or more groups. Additionally, for comparing statistical significance between two categorical variables, Pearson's Chi-squared test and Fisher's Exact Test were applied. For comparing categorical variables with more than two groups, Pairwise Fisher's Exact Test was utilized to assess statistical significance between groups. All analyses were conducted using R Studio and the R programming language. P-values less than 0.05 were considered statistically significant.

## Results

*General findings*

Seventy-three patients who underwent lumbar spinal canal surgery were investigated. Summary of the continuous variables are shown in the Table 1.

**Table 1.** Data regarding the general distribution of data in continuous variables

| | Number of samples (N) | Min. - Max. | Mean∓SD | 25th percentile | 50th percentile (median) | 75th percentile | Shapiro-Wilk Normality Test |
|---|---|---|---|---|---|---|---|
| **Age** | 73 | 36 - 80 | 61.3∓8.7 | 56 | 62 | 68 | W=0.97325, p=0.1227 |
| **Height (cm)** | 73 | 148 - 198 | 165.7∓10.1 | 159 | 165 | 171 | W=0.96155, p=0.02546 |
| **Weight (kg)** | 73 | 45 - 105 | 81∓12.8 | 70 | 82 | 90 | W=0.95779, p=0.01555 |
| **BMI** | 73 | 17.6 - 37.6 | 29.5∓3.9 | 27.78 | 29.97 | 31.53 | W=0.97279, p=0.1154 |
| **Preoperative walking distance (m)** | 73 | 5 - 2000 | 219.3∓355.9 | 30 | 100 | 200 | W=0.59327, p=6.515e-13 |
| **Postoperative walking distance (m)** | 73 | 2 - 1500 | 812.9∓371.2 | 1000 | 1000 | 1000 | W=0.60374, p=9.812e-13 |
| **RMDQ** | 67* | 0 - 24 | 10.4∓6.5 | 6 | 9 | 15.5 | W=0.962, p=0.0387 |
| **Number of Laminectomies** | 73 | 1 - 6 | 2∓1 | 1 | 2 | 2 | W=0.81677, p=4.26e-08 |
| **Duration of surgery (min)** | 73 | 85 - 420 | 209.4∓72.2 | 165 | 195 | 230 | W=0.93612, p=0.001111 |
| **Blood Used in Surgery (cc)** | 73 | 0 - 1000 | 169.9∓291.9 | 0 | 0 | 400 | W=0.6313, p=2.993e-12 |

*missing values were removed prior to calculating the percentiles. Note: Age and BMI exhibit a normal distribution

The average follow-up period was 45.5±21.8 months (minimum 6.5, maximum 84.8). There were 32 male and 41 female patients with an average age of 61.3±8.7 (minimum 36, maximum 80). Six patients (2 male and four female) underwent reoperation, and even though 4 of these six patients stated they were satisfied, they were considered unsuccessful. Of the remaining 67 patients, four reported being dissatisfied with the outcome, while 11 were unsure whether they were satisfied. All 15 of these patients were considered unsuccessful. Thus, 52 patients who had not undergone reoperation and were happy with the surgery were deemed successful. Neurogenic claudication (needing to sit down after walking distances shorter than 1000 meters) was present in 66 out of 73 preoperatively and 17 postoperatively.

*Comparative findings*

Outcome Parameters according to the operation methods (Table 2): A total of 45 patients in the study had only total laminectomy, while the remaining 28 patients had stabilization in addition to total laminectomy. The success rate in the whole stabilization group (24 patients, 85.7%) was not different statistically from those in the non-stabilized group (29 patients, 64.4%) (p=0.06098). However, when patients were grouped according to the number of stabilized segments, the stabilization group showed significant internal differences. Of the 28 patients who underwent stabilization, 22 had 1-2 segments stabilized, while six had three or more segments stabilized. Patients with one or two segments stabilization (Group 2) were found to be more successful than patients without any stabilization (Group 1) (p=0.0195).

Representative cases illustrating the successful outcomes of laminectomy with and without stabilization are provided in Figure 1 and Figure 2, respectively. No difference was found in terms of success between the group with only laminectomy without stabilization (Group 1) and the group with laminectomy plus three or more segment stabilization (Group 3) (p=1).

Roland-Morris scores also differed between these three groups (Roland Morris median for Group 1: 9, Group 2: 11, Group 3: 16; p=0.02). In pairwise comparisons, it was found that Roland Morris disability questionnaire scores were lower in Group 1 than in Group 3 (p=0.0026). However, there was no statistically significant difference between Group 1 and Group 2 and Group 2 and Group 3.

The incidence of postoperative neurogenic claudication differed among the groups (11/45, 1/22, 5/6 for Group 1, Group 2, and Group 3, respectively; p<0.001). This difference was present between Group 2 and Group 3 (p=0.0011), between Group 1 and Group 3 (p=0.0268), but not between Group 1 and Group 2 (p=0.2580).

Outcome Parameters according to the other independent variables (Table 3):

**Table 2.** Dependent variables (outcome parameters)according to the operation methods

| Outcome parameter and compared groups | P value | Groups (operation methods) | | | | | |
|---|---|---|---|---|---|---|---|
| **Success: Gr. 1 vs Gr. 2 & Gr. 3** | 0.06098* | Gr. 1 | | | Gr. 2 & 3 | | |
| | | Suc. | | Uns. | Suc. | | Uns. |
| | | 29 | | 16 | 24 | | 4 |
| **Success: Gr. 1 vs Gr. 2 vs Gr. 3** | **0.005264*** | Gr. 1 | | Gr. 2 | | Gr. 3 | |
| | | Suc. | Uns. | Suc. | Uns. | Suc. | Uns. |
| | | 29 | 16 | 21 | 1 | 3 | 3 |
| **Success: Gr. 1 vs Gr. 2** | **0.0195*** | Gr. 1 | | | Gr. 2 | | |
| | | Suc. | | Uns. | Suc. | | Uns. |
| | | 29 | | 16 | 21 | | 1 |
| **Success: Gr. 1 vs Gr. 3** | 1.0000* | Gr. 1 | | | Gr. 3 | | |
| | | Suc. | | Uns. | Suc. | | Uns. |
| | | 29 | | 16 | 3 | | 3 |
| **Success: Gr. 2 vs Gr. 3** | 0.0667* | Gr. 2 | | | Gr. 3 | | |
| | | Suc. | | Uns. | Suc. | | Uns. |
| | | 21 | | 1 | 3 | | 3 |
| **RMDQ: Gr. 1 vs Gr. 2 vs Gr. 3** | **0.02**** | Gr. 1 RMDQ median | | Gr. 2 RMDQ median | | Gr. 3 RMDQ median | |
| | | 9 | | 11 | | 16 | |
| **RMDQ: Gr. 1 vs Gr. 2** | 0.0750* | Gr. 1 RMDQ median | | | Gr. 2 RMDQ median | | |
| | | 9 | | | 11 | | |
| **RMDQ: Gr. 1 vs Gr. 3** | **0.0026**** | Gr. 1 RMDQ median | | | Gr. 3 RMDQ median | | |
| | | 9 | | | 16 | | |
| **RMDQ: Gr. 2 vs Gr. 3** | **0.0270**** | Gr. 2 RMDQ median | | | Gr. 3 RMDQ median | | |
| | | 11 | | | 16 | | |
| **PO WD: Gr. 1 vs Gr. 2 vs Gr. 3** | **<0,0001 **** | Gr. 1 WD mean | | Gr. 2 WD mean | | Gr. 3 WD mean | |
| | | 796.22 | | 972.73 | | 352.5 | |
| **PO WD: Gr. 1 vs Gr. 2** | **0.0324**** | Gr. 1 WD mean | | | Gr. 2 WD mean | | |
| | | 796.22 | | | 972.73 | | |
| **PO WD: Gr. 1 vs Gr. 3** | **0.0013**** | Gr. 1 WD mean | | | Gr. 3 WD mean | | |
| | | 796.22 | | | 352.5 | | |
| **PO WD: Gr. 2 vs Gr. 3** | **0.0001**** | Gr. 2 WD mean | | | Gr. 3 WD mean | | |
| | | 972.73 | | | 352.5 | | |
| **PO NC: Gr. 1 vs Gr. 2 vs Gr. 3** | **0.0005481*** | Gr. 1 | | Gr. 2 | | Gr. 3 | |
| | | NC+ | NC- | NC+ | NC- | NC+ | NC- |
| | | 11 | 34 | 1 | 21 | 5 | 1 |
| **PO NC: Gr. 1 vs Gr. 2** | 0.2580* | Gr. 1 | | | Gr. 2 | | |
| | | NC+ | | NC- | NC+ | | NC- |
| | | 11 | | 34 | 1 | | 21 |
| **PO NC: Gr. 1 vs Gr. 3** | **0.0268*** | Gr. 1 | | | Gr. 3 | | |
| | | + | | - | + | | - |
| | | 11 | | 34 | 5 | | 1 |
| **PO NC: Gr. 2 vs Gr. 3** | **0.0011*** | Gr. 2 | | | Gr. 3 | | |
| | | + | | - | + | | - |
| | | 1 | | 21 | 5 | | 1 |

Gr. 1: only decompressed; Gr. 2 decompressed and additionally 1-2 segments stabilized, Gr. 3: decompressed and additionally 3 or more segments stabilized, PO: Postoperative Gr.: Group, Suc.: Successful, Uns.: Unsuccessful, NC: Neurogenic Claudication, WD: Walking Distance. * Fisher's Exact Test. ** Kruskal-Wallis rank sum test

There was no difference in success rate and Roland Morris scores between the sexes. The occurrence of neurogenic claudication in the postoperative period was more frequent in women (14/41) compared to men (3/32) (p=0.02374). No association was found between age and success, Roland Morris scores, or walking distance after surgery.

When examining the relationship between the number of laminectomies and success, the average number of laminectomies in unsuccessful patients (2.4±1.2) was slightly higher than those in successful patients (2.0±0.9); however, this was not statistically significant (p=0.129).

Our study also considered the presence of preoperative degenerative spondylolisthesis in patients. Degenerative spondylolisthesis was detected in 48,9% (22 patients) who underwent only decompression and 85.7% (24 patients) who also had stabilization. However, degenerative spondylolisthesis did not affect success rates, Roland Morris disability questionnaire scores, or postoperative neurogenic claudication rates.

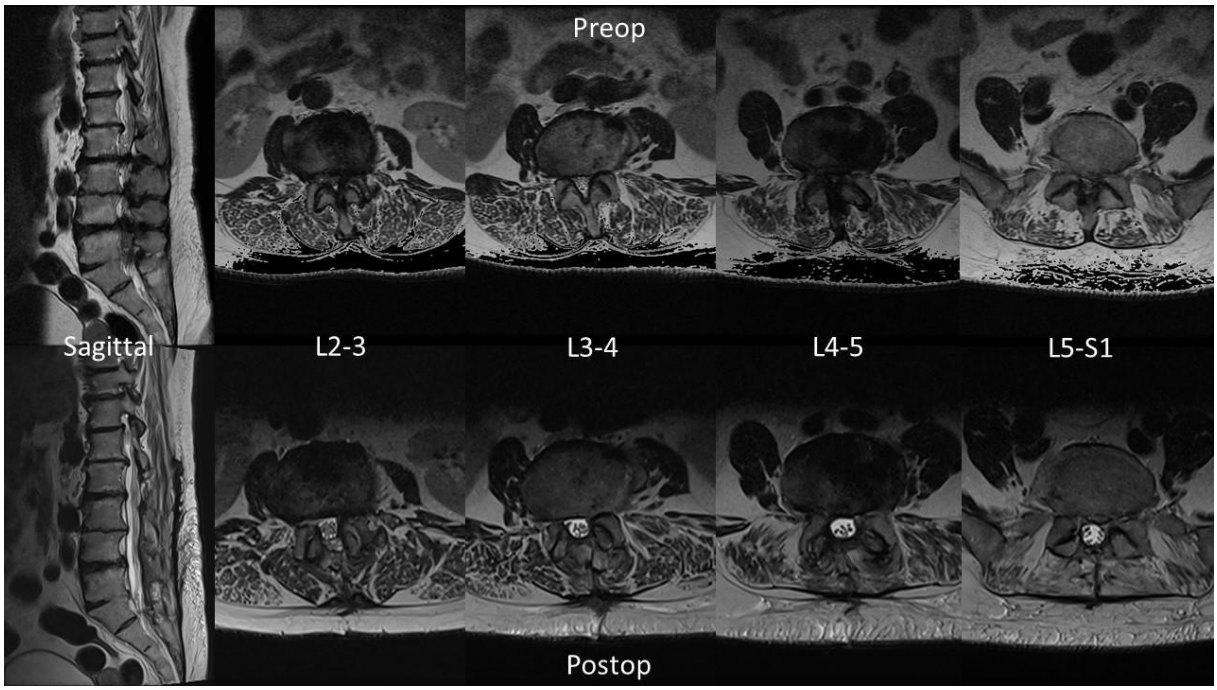


**Figure 1.** Pre and postoperative lumbar T-2 weighted MRI images of patient #74, a 68-year-old female who presented with a complaint of neurogenic claudication after walking 100 steps. A total of 4 levels of laminectomy were performed at L2-3-4-5. The walking restriction was eliminated postoperatively. The Roland Morris score was 18. The patient was satisfied with the surgery, and there was no need for reoperation; the case was considered "successful" in the study.

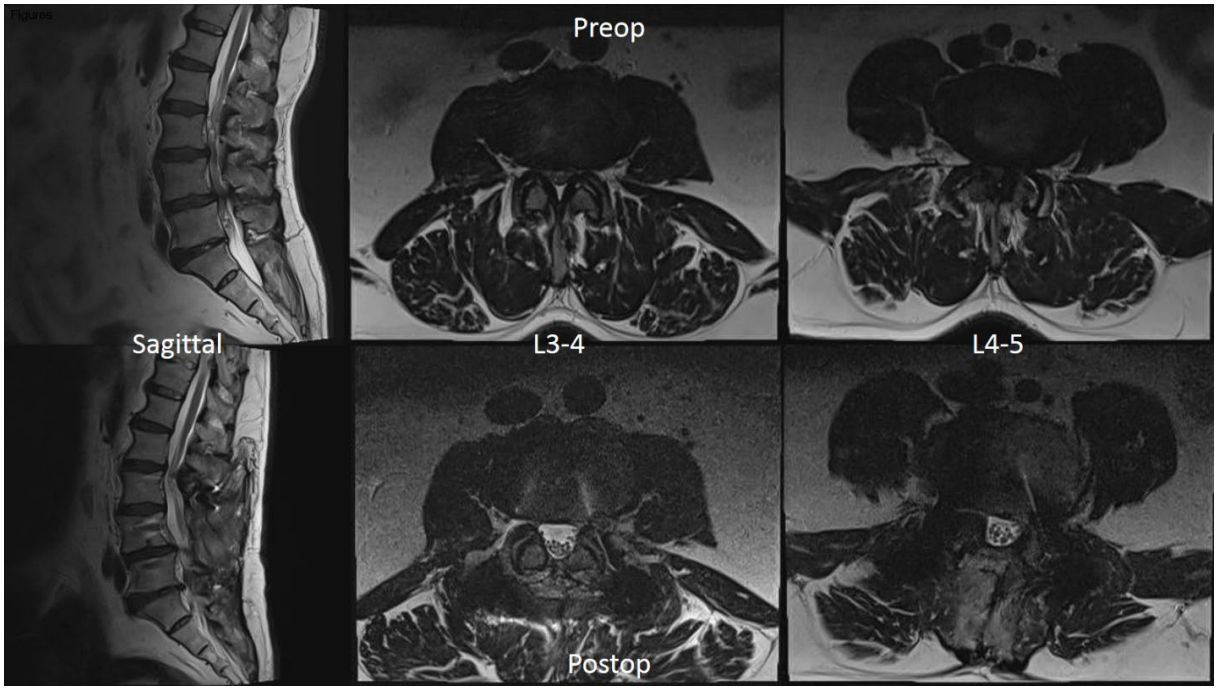


**Figure 2.** Pre and postoperative lumbar T-2 weighted MRI images of patient #50, a 64-year-old male patient who described neurogenic claudication after 100 meters. Radiologically, severe stenosis was present at L3-4 and L4-5, L4 grade I spondylolisthesis, and minimal degeneration at L5-S1. L3 and L4 total laminectomy and stabilization of L3-4-5 were performed, after which the walking distance became unlimited. The Roland Morris score was 14. The patient was satisfied with the surgery, and there was no need for reoperation; the case was considered "successful" in the study

**Table 3.** Dependent variables (outcome parameters) according to the other independent variables

| Dependent Variable: Independent Variable | P value | Independent Variable Groups | | | |
|---|---|---|---|---|---|
| **Success: Sex** | 0.06459* | Male | | Female | |
| | | Suc. | Uns. | Suc. | Uns. |
| | | 27 | 5 | 26 | 15 |
| **Success: Age** | 0.6*** | | | | |
| **Success: DS** | 0.4235* | DS + | | DS - | |
| | | Suc. | Uns. | Suc. | Uns. |
| | | 35 | 11 | 18 | 9 |
| **Success: NoL** | 0.1295** | | | | |
| **Success: DT** | **0.02148*** | DT + | | DT - | |
| | | Suc. | Uns. | Suc. | Uns. |
| | | 4 | 6 | 49 | 14 |
| **RMDQ: Sex** | 0.2085** | M RMDQ median | | F RMDQ median | |
| | | 9 | | 11 | |
| **RMDQ: Age** | 0.9023**** | | | | |
| **RMDQ: DS** | 0.6988** | DS + RMDQ Median | | DS - RMDQ median | |
| | | 9 | | 10.5 | |
| **RMDQ: NoL** | 0.6437**** | | | | |
| **RMDQ: DT** | **0.02896**** | DT + RMDQ median | | DT - RMDQ median | |
| | | 16 | | 9 | |
| **PO WD: Sex** | **0.02854**** | M WD mean | | F WD mean | |
| | | 925.78 | | 724.88 | |
| **PO WD: Age** | 0.2736**** | | | | |
| **PO WD: DS** | 0.4411** | DS+ WD mean | | DS - WD mean | |
| | | 842.22 | | 763.07 | |
| **PO WD: NoL** | **0.01186**** | | | | |
| **PO WD: DT** | 0.1493** | DT + WD mean | | DT - WD mean | |
| | | 656.5 | | 837.78 | |
| **PO NC: Sex** | **0.02374*** | M | | F | |
| | | NC + | NC - | NC + | NC - |
| | | 3 | 29 | 14 | 27 |
| **PO NC: Age** | 0.052*** | | | | |
| **PO NC: DS** | 0.3941* | DS + | | DS - | |
| | | NC + | NC - | NC + | NC - |
| | | 9 | 8 | 37 | 19 |
| **PO NC: NoL** | **0.02406**** | | | | |
| **PO NC: DT** | **0.04629*** | DT + | | DT - | |
| | | NC + | NC - | NC + | NC - |
| | | 5 | 5 | 12 | 51 |

NS: Not significant relationship PO: Postoperative, NC: Neurogenic Claudication, WD: Walking Distance, DS: Degenerative Spondylolisthesis, M: Male, F: Female, DT: Dural Tear, NoL: Number of Laminectomies. * Fisher's Exact Test. ** Mann-Whitney U Test. *** ANOVA Test. **** Spearman's Rank Correlation Analysis

In the study, dural tears occurred in 7 patients in the group who underwent only decompression and in 3 patients who underwent decompression with added stabilization. No significant difference was detected between patients who underwent only decompression and those who underwent decompression with added stabilization regarding dural tear occurrence. However, it was observed that the absence of dural injury during surgery increased the success rate in both groups (p=0.021, Fisher's Exact Test). Patients who experienced dural tears had higher Roland Morris disability questionnaire scores (p=0.02896). The incidence of neurogenic claudication in the postoperative period was found to be higher (5/10) in those with dural tears compared to those without dural tears (12/63) (p=0.046).

No statistically significant effect of the other investigated independent variables on the postoperative dependent variables was found.

## Discussion

Lumbar spinal stenosis (LSS) is a common problem in older people that frequently results in significant impairment of life comfort, causing low back pain, neurogenic claudication, and radiculopathy. For patients who do not improve with nonsurgical treatments, several surgical treatment options (such as laminectomy, the addition of fusion surgery to laminectomy, interspinous spacer, minimally invasive lumbar decompression, and trans-spinous split laminectomy) are available. The rare occurrence of rapid deterioration in LSS and periods with mild fluctuations in symptoms over time have made the surgical option an almost elective procedure. The surgical procedure has significantly varied from clinic to clinic (6). The number of operations in LSS cases has increased nearly eight-fold between 1979 and 1992 relative to the total diagnosed cases and has plateaued since

then (7,8). In recent years, although the surgical rate (1-2 per 1000 patients) remains stable and unchanged relative to all patients with spinal stenosis, lumbar fusion as a surgical preference has increased dramatically (9,10). This increase varies according to the geographical areas in the studies, with a 14-20 fold increase in fusion surgery rates in addition to the eight-fold increase in decompression surgery (9,10). Possible reasons for this variation include difficulties in reaching a consensus among surgeons on indications for surgery and differences in surgeons' experience and training (11).

While the success rate was notably higher in men (84.3%, 27/32) than in women (63.4%, 26/41), this difference did not reach statistical significance (p=0.0645) Maclean et al. analyzed the relationship between gender and postoperative pain scores, disability scales, and quality of life assessments in a review of 30 studies involving 32,951 patients. (12) They reported that the female gender had worse values on most scales, and in the remaining tests, the male gender did not have worse values in any of them. These findings provide compelling evidence that postoperative satisfaction may indeed vary according to gender.

In our study, we did not find a significant relationship between age and postoperative success. However, conflicting results are present in the literature. For example, Katz et al. (13) found no significant relationship between age and patient satisfaction, while Mariconda et al. (14) reported worse outcomes in terms of neurological deficit at 1-year follow-up and demonstrated that advanced age was associated with a poorer prognosis. Amundsen et al. (15) argued that advanced age or degenerative changes are unrelated to poor prognosis. Athiviraham et al. (16) reported that age and gender did not significantly alter the outcomes based on postoperative Roland Morris scores. All these results indicate that the impact of age on postoperative success can be interpreted differently. Therefore, further research is needed to understand age's effect on postoperative success. Our study results show that the effect of age on postoperative success is limited.

Our analysis revealed no statistically significant association between the number of laminectomies performed and success. Conflicting results have been published in the literature on this subject. Ulrich et al. (17) reported that multilevel decompression was associated with worse outcomes when comparing patients who underwent single-level decompression with those who underwent multilevel decompression. However, some studies show no relationship between the amount of decompression and patient outcomes (15,18). Park et al. (19) found no difference in the 2-year results when comparing one-level and more-than-one-level decompression in patients with pure spinal stenosis (without degenerative spondylolisthesis).

In our series, the presence of degenerative spondylolisthesis in addition to lumbar spinal stenosis did not change the success rate. Different results have been reported in the literature in cases of degenerative spondylolisthesis accompanying lumbar stenosis. Försth et al. found that "adding fusion surgery to decompression did not provide additional benefits for patients with degenerative spondylolisthesis" (20). Park et al. (19) reported that the 2-year outcomes of patients who underwent single-level decompression were better than those who underwent multilevel decompression in patients with spinal stenosis and degenerative spondylolisthesis.

This study's data highlights despite 1-2 level stabilization being generally more successful, the sudden decrease in success when the stabilized segment exceeded two levels indicates the importance of planning the operation to include as few segments as possible if stabilization is required in LSS surgeries. Different results have been reported on this subject in the literature. For example, when examining whether or not fusion is added to decompression, Försth et al. claimed that adding fusion surgery to decompression did not provide any additional benefits for all patients (with and without listhesis) (20). In addition, Chang et al. conducted a meta-analysis of 17,785 cases. They concluded no difference in the assessed pain scores, ODI, and EQ-5D quality of life scale when adding fusion to decompression. They felt adding fusion in spinal stenosis surgery was not very positive since it increased operation time, blood loss, and hospital stay (21). On the other hand, some studies show that adding fusion to decompression helps achieve better outcomes than decompression surgery alone. For example, Ghogawala et al. found that laminectomy plus fusion provided better functional results and lower revision surgery rates than laminectomy alone in LSS and stable degenerative spondylolisthesis (22). Austevoll et al. showed that ODI outcomes were similar at the 12-month follow-up, but the fusion group had less back and leg pain. However, they did not attribute superiority to any method since the operation time and length of hospital stay were more prolonged (23).

In the literature, there are various findings regarding the relationship between the length of stabilization in lumbar spinal stenosis surgery and clinical outcomes. Sun et al. found no significant difference in scores when comparing long and short stabilization in lumbar spinal stenosis treatment (24). In contrast, Lee et al. showed that in patients with lumbar spinal stenosis, those who underwent short segment fusion (1-2 segments) with decompression had better results in scores evaluated at 10-year follow-up compared to those who underwent long segment fusion (3 or more sections) (25).

The discrepancies in the literature may be due to differences in study methods, measurement tools,

and patient populations. For example, Försth et al. (20) used Oswestry and VAS scales in their study. Chang et al. (21) used ODI and EQ-5D scales. As mentioned above, in our research, fusions with fewer segments were observed to be more successful when patient satisfaction was considered. It cannot be said that the research results using different evaluation tools contradict each other.

Our findings reveal that the success rate is lower for patients experiencing dural tears during surgery. This finding is consistent with the literature. For example, in a study conducted by Alhaug et al. (26), they found that, during the 12-month follow-up of 8,919 patients, those with dural tears had lower ODI scores, and a higher number of patients worsened. Therefore, it can be concluded that a dural tear negatively affects surgical outcomes. The consistency of our findings with the literature increases the importance and reliability of this conclusion.

As expected, there was a statistically significant association between postoperative Roland-Morris score and success ($p=0.003$). Regarding statistical significance, the most meaningful threshold was found to be 17. That is, while successful cases were the majority (89.2% successful) in the 0-17 range, unsuccessful cases were the majority (56.3% unsuccessful) in the 18-24 range ($p<0.0001$, chi-square test). Although both are dependent variables, investigating the relationship between Roland Morris and success will demonstrate the likelihood of patient satisfaction or, by our standards, the possibility of the surgery being successful based on the RMES score.

The lack of a statistically significant relationship with success for some independent variables may be due to the small size of our series. Therefore, investigating the relationship between these factors and success in a more extensive series is worth exploring.

## Conclusion

Based on the results of our study, we have concluded that lumbar stabilization, when limited to 1-2 segments, is associated with higher patient satisfaction. However, as the number of stabilized segments increases, the positive impact on patient satisfaction may decrease. Our study highlights the importance of exercising utmost care and employing meticulous techniques during surgery to avoid dural tears, as our results indicate that the occurrence of dural tears significantly impacts postoperative success. We believe future prospective studies with larger sample sizes will provide more insight into this matter.

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None.

## Conflict of interest statement

The authors declare no conflicts of interest.

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