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IMPACT OF LUMBAR SURGERY ON PAIN, SLEEP QUALITY, AND QUALITY OF LIFE: A PRE-POST DESIGN STUDY OF COMMON LOW BACK DISEASE

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ABSTRACT

Objective: Low back pain is common among individuals over 15 years and often leads to hospitalizations. Impaired sleep quality is a major complication. Pain and sleep interact in a vicious cycle in which pain disrupts sleep and poor sleep worsens pain. This study aimed to assess changes in sleep quality and quality of life after lumbar surgery.

Materials and Methods: A total of 106 patients underwent lumbar surgery between December 2023 and April 2024. Assessments were performed preoperatively and at 6 months postoperatively using the visual analog scale (VAS), Pittsburgh sleep quality index (PSQI), and EuroQol 5-dimension questionnaire (EQ-5D-3L).

Results: The cohort included 56 females (53%), with ages ranging from 23-78 years. Surgery was performed for lumbar spinal stenosis in 37 (35%), lumbar spondylolisthesis (LSL) in 31 (30%), and lumbar disc herniation (LDH) in 38 (35%). Postoperatively, VAS and PSQI scores decreased significantly, while EQ-5D-3L scores increased.

Conclusion: Lumbar surgery provided meaningful improvements in pain, sleep, and quality of life, particularly in patients who were unresponsive to conservative therapy. The most pronounced benefits occurred in LDH, whereas notable gains were also observed in LSL, a condition rarely studied in this context. These outcomes may reflect the less invasive nature of decompression compared with that of fusion. Overall, lumbar surgery represents an effective treatment option and offers new insights into the relationship between spinal disorders and sleep quality.

Keywords: Low back pain, quality of life, sleep quality

INTRODUCTION

Low back pain (LBP) affects approximately 80% of individuals at some point in their lives, with its prevalence increasing with age[1]. In Türkiye, it ranks as the leading cause of hospital admissions among individuals over the age of 158[2]. The lumbar region is the main load-bearing and mobile part of the spine. Consequently, it is also the site where degenerative changes, injuries, and pain most frequently occur[3]. In the management of LBP, treatment should be planned according to established algorithms, with conservative methods applied initially. The primary goal is to control symptoms and minimize functional impairment caused by pain. However, in certain cases, surgical intervention becomes unavoidable. Absolute surgical indications include cauda equina syndrome, progressive motor deficit, and failure of conservative treatment[4].

It has been emphasized in the literature that LBP not only leads to pain and functional impairment, but also has a significant negative impact on sleep patterns and overall quality of life[5]. Sleep, constituting a substantial portion of one's lifetime, is essential for both physical and mental health. Its absence or poor quality can negatively impact various aspects of life, including work performance, academic achievements, daily functioning, and overall well-being[6]. LBP may impair sleep quality, while reduced sleep quality in turn exacerbates pain and creates a vicious cycle. However, stronger evidence suggests that sleep disturbances represent a risk factor for the development and persistence of LBP[7]. In the literature, the effects of chronic LBP, gabapentin use, medical treatment, and surgical treatment [particularly in patients with lumbar disc herniation (LDH) or lumbar spinal stenosis (LSS)] on sleep quality and daily activities have been investigated[7-9].

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While LDH, LSS and lumbar spondylolisthesis (LSL) have each been extensively investigated, studies that concurrently evaluate all three conditions within a homogeneous patient cohort and within the same temporal framework are notably scarce.

The aim of this study was to evaluate the effects of surgical interventions performed for LDH, LSS, and LSL on Pittsburgh sleep quality index (PSQI), pain [visual analog scale (VAS)], and quality of life [EuroQol 5-dimension questionnaire (EQ-5D-3L)] and to further compare the impact of surgery on pain, sleep quality, and quality of life among patients with these three diagnoses.

MATERIALS AND METHODS

Study Design

This study followed a prospective pre-post design and included 106 patients who underwent lumbar decompression surgery for LDH and decompression with posterior transpedicular instrumented fusion for LSS and LSL at the spine center of a tertiary referral hospital between December 2023 and April 2024. All surgical procedures were performed at a single center. Among the participants, 31 patients were diagnosed with LSL, 37 with LSS, and 38 with LDH. The date of the last surgical procedure was April 30, 2024, and the final follow-up assessment was completed on October 31, 2024. Of the initially eligible patients, three could not be reached at the 6-month postoperative follow-up, and one patient did not complete the 6-month postoperative questionnaire.

Inclusion criteria for surgery were as follows: for LDH, patients were selected based on the presence of radicular pain, motor weakness, and failure of conservative treatment (defined as persistent symptoms despite at least 6 weeks of non-operative management, including physical therapy, analgesic medications, and/or steroid injections). For LSS, patients with a canal diameter less than 10 mm (measured on axial T2-weighted magnetic resonance imaging at the narrowest level and independently assessed by a neurosurgeon and a radiologist), radicular pain, motor weakness, positive neurogenic claudication, and failure of conservative treatment were included. For LSL, patients with Meyerding grade 1-2, either degenerative or isthmic type, motor weakness, radicular pain, positive neurogenic claudication, and no improvement with conservative treatment were considered eligible for surgery and were enrolled in the study.

Exclusion criteria encompassed patients with recurrence, patients younger than 18 years of age, patients who had undergone surgery due to knee and/or hip osteoarthritis; patients with spinal infection; patients with radiological findings of spinal tumor; patients with spondylolisthesis or disc pathology after trauma; patients with sleep apnea; those with advanced heart failure, pulmonary disease, psychiatric disorders or related medication use; night-shift workers; and patients with a body mass index greater than 30 kg/m^2 were excluded from the study. These criteria were intended to reduce the influence of major comorbidities that could affect postoperative pain, sleep, and quality of life outcomes, thereby allowing the evaluation of a more homogeneous patient cohort. Exclusion criteria were determined based on diagnostic records in patient files, clinical history, and routine preoperative assessment findings, without the use of additional screening instruments.

Perioperative pain management and sleep-related treatment were administered according to the institution's standard clinical practice. The same analgesic and sleep-related treatment regimen was applied during both the preoperative and postoperative periods, with no systematic changes made throughout the follow-up period. (e.g., non-steroidal anti-inflammatory drugs, muscle relaxants, tramadol, and opioids).

The sample size for the study was calculated as a minimum of 90 with an alpha error of 0.05, a power of 80% and an effect size of 0.3 using the G*Power v3.1 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) programme. After voluntarily agreeing to participate in the study, subjects who completed both questionnaires completely were included in the study. Ethical approval was obtained from the Ankara Yıldırım Beyazıt University (approval no: 10-497, date: 19.12.2023).

Data Collection

VAS, PSQI and EQ-5D-3L evaluation scales were performed preoperatively and at 6 months postoperatively in the 106 patients included in the study. The questionnaires were administered through face-to-face interviews by a separate researcher who was blinded to the patients' diagnoses, while the diagnoses were independently established by the investigators. In the first part, age, gender and diagnosis information of the participants were recorded. In the second part, the pain levels of the participants were determined using VAS. The participants rated the severity of radicular leg pain on a scale ranging from 0 (no pain) to 10 (most severe pain)[10]. In the third part, PSQI was used to determine sleep quality. PSQI is a scale consisting of 24 questions and 7 components. Nineteen of the 24 questions are answered by the person himself/herself and used in the assessment. The other 5 questions are answered by the person's relatives and are not used in the assessment. The 19 questions included in the assessment are distributed in 7 components. Each component is scored between 0 to 3. The total score of the scale is obtained by summing the scores of these components and takes values between 0-21. An increase in the total score indicates deterioration in sleep quality. Although the PSQI does not indicate whether there is a sleep disorder, a total score of 5 and above means poor sleep quality. PSQI was developed by Buysse et al.[11] in 1989 and its Turkish validity and reliability study was conducted by Ağargün et al.[12] in 1996.

The fourth part of the study employed the EQ-5D-3L general quality of life scale to evaluate participants' quality of life. This scale comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension offers response options of 1 (no problems), 2 (some problems), and 3 (extreme problems). The total score ranges from -0.59 to 1, with 1 denoting perfect health and 0 indicating death. Scores below zero represent health states considered worse than death, such as unconsciousness or being bedridden. Originating in 1987, the scale was developed by the EuroQol Group and has since been translated into over 60 languages, including Turkish[13]. The Turkish validity and reliability study of the scale was conducted by Kahyaoğlu Süt[14] in 2009 as part of a master's thesis in internal medicine nursing involving patients with acute coronary syndrome. For this study, scoring values outlined in Golicki et al.'s[15] work were adopted.

Statistical Analysis

Statistical analysis were conducted using IBM-SPSS v25 software (IBM Corp., Armonk, NY, USA). Descriptive statistics, including median, 1st and 3rd quartiles, and percentages, were utilized to present participant characteristics. Normality analyses was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Parametric tests were used when the dependent variables showed normal distribution; otherwise non-parametric tests were used. Due to the non-normal distribution of the data, the Wilcoxon paired two-sample test with Bonferroni correction was employed to evaluate changes in sleep quality, pain scores, and quality of life before and after intervention. To compare differences in these variables between groups based on age, gender, and diagnosis, the Mann-Whitney U test and Kruskal-Wallis test were applied. The effect size of postoperative scale score changes for all three diagnostic group was evaluated and classified using the eta squared coefficient[16]. In this study pain level (VAS), health related quality of life (EQ-5D-3L) and sleep quality of participants were defined as three pre-determined co-primary endpoints. The sub-dimensions of the PSQI were evaluated as secondary analysis to examine the components of variation in sleep quality, and a significance level of $p<0.007$ was set using Bonferroni correction to control for multiple comparisons. Moreover, to evaluate the impact of baseline differences on score change, a multiple linear regression analysis was conducted with EQ-5D-3L pre- and postoperative scores as dependent variable. Baseline EQ-5D-3L score of the participants, diagnostic groups and their interaction term were included as independent variables. Age was categorized into two groups: 65 years and older, and younger than 65 years. Subgroup analysis were performed on quality of life, sleep quality, and pain score changes within specific diagnostic groups. For variables conforming to a normal distribution, the Student's t-test was used, while the Mann-Whitney U test was applied for non-normally distributed data.

RESULTS

A total of 106 patients completed both surveys and were included in the study. Of these, 56 (53%) were women. The median age was 57 years (range 23-78). Surgery was performed for LSS in 37 patients (35%), for LSL in 31 (30%), and for LDH in 38 (35%) (Table 1).

Among 38 LDH patients, levels were L2-3 in 1 (2.6%), L3-4 in 3 (7.9%), L4-5 in 17 (44.7%), and L5-S1 in 17 (44.7%). Of 31 LSL patients, 4 (12.9%) had L3-4 (all degenerative), 16 (51.6%) had L4-5 (4 isthmic, 12 degenerative), and 11 (35.5%) had L5-S1 (10 isthmic, 1 degenerative). Among 37 LSS patients, 24 (64.9%) had 2 levels involved, 12 (32.4%) had 3 levels, and 1 (2.7%) had 4 levels.

In the baseline, the VAS and PSQI total scores of LSS, LSL and LDH patient groups were similar ($p>0.05$ for each). However, while the baseline EQ-5D-3L scores of the LSS and LSL groups were similar, the EQ-5D-3L score of the LDH group was lower ($p=0.032$). As a result of the multiple linear regression analysis conducted to evaluate the effect of baseline differences on change in EQ-5D-3L scores, the findings indicate that the observed improvement can not be attributed solely to the lower baseline scores in the LDH group. The results demonstrate that the surgical response varies according to both diagnostic category and baseline quality of life level.

The VAS scores of participants significantly improved, decreasing from a preoperative median of 10 (range: 9-10) to a postoperative median of 1 (range: 0-1). Similarly, the PSQI total scores showed significant improvement, decreasing from a preoperative median of 15 (range: 14-16) to a postoperative median of 4.5 (range: 3-6). The EQ-5D-3L general quality of life scores increased markedly from a preoperative median of 0.10 (range: -0.17-0.53) to a postoperative median of 1 (range: 0.89-1).The changes in VAS, PSQI total scores, and EQ-5D-3L scores were statistically significant. Additionally, the changes in six subcomponents of the PSQI scale, excluding sleep duration, were also found to be statistically significant (Table 2).

In all three surgical groups, significant postoperative improvements were observed in EQ-5D-3L quality of life, PSQI sleep quality, and VAS pain scores ($p<0.05$). Among these, the LDH group demonstrated the most pronounced gains, with moderate to large effect sizes for quality of life, sleep quality, and pain reduction. By diagnosis, only LDH patients

Table 1. Baseline characteristics of the participants

Characteristics	Median (IQR1-IQR3)
Age	57 (49-64)
	n (%)
Gender	
1. Female	56 (53)
2. Male	50 (47)
Diagnosis	
1. LSS	37 (35)
2. LSL	31 (30)
3. LDH	38 (35)

IQR: Interquartile range, LSS: Lumbar spinal stenosis, LSL: Lumbar spondylolisthesis, LDH: Lumbar disc herniation showed significant improvements across all three measures, with greater gains compared to the other groups (quality of life, p=0.008; sleep quality, p=0.008; pain reduction, p=0.004). In addition the eta squared sizes of postoperative scale score changes for all three diagnosis were found between 0.07-0.09, indicating that these changes had a moderate-high clinical impact (Table 3).

Moreover when the diagnostic groups were divided into two groups those who underwent instrumentation (LSS, LSL) (n=68) and those who did not (LDH) (n=38) the change in scale scores from the preoperative and postoperative period was higher in the intrumentation group for VAS and PSQI scales (p<0.001 and p=0.002, respectively), whereas the change in EQ-5D-3L scores was significantly higher in the non-instrumentation group (p=0.02)

Changes in VAS, PSQI, and EQ-5D-3L were analyzed by age, gender, and diagnosis. VAS improvement was greater in patients <65 years (p=0.02), while EQ-5D-3L and PSQI showed no age-related differences. Men had a larger reduction in PSQI scores than women (p=0.02), with no gender differences in VAS or EQ-5D-3L (Table 4). Among 36 LSS patients (23 with two levels, 13 with three levels), VAS reduction was greater in two-level cases (p=0.038), while EQ-5D-3L and PSQI showed no group differences.

In LSL patients, EQ-5D-3L, PSQI, and VAS changes did not differ between L4-5 (n=16) and L5-S1 (n=11) levels, nor between isthmic (n=14) and degenerative (n=17) types (p>0.05).

In LDH patients, EQ-5D-3L, PSQI, and VAS changes were similar at L4-5 (n=17) and L5-S1 (n=17) levels (p>0.05).

No complications requiring reoperation, such as spondylodiscitis, permanent neurological deficits, or implant issues, were observed in the 106 patients during the postoperative period and 6-month follow-up. Minor complications included dural tears in 7 patients, which were repaired. Two patients had partial nerve root damage, but no additional deficits were noted postoperatively. One patient had a misplaced screw that contacted the nerve root, but it was corrected during surgery, and the patient experienced temporary weakness for 6 hours. Additionally, 5 patients had fat necrosis at the wound site, which resolved with treatment.

DISCUSSION

Several studies have investigated the impact of LSS and LDH on sleep quality. Some of these have focused on preoperative LDH[17], while others have examined outcomes in postoperative LDH[18,19]. In addition, studies have evaluated preoperative LSS[20,21] as well as pre- and postoperative comparisons in LSS[22-24]. Beyond these, previous studies have

Table 2. Comparison of pre- and postoperative changes in VAS, PSQI and EQ-5D-3L scores

Scale	Preoperative median (IQR1/IQR3)	Postoperative median (IQR1/IQR3)	p-values
EQ-5D-3L index score	0.10 (-0.17/0.53)	1 (0.89/1)	**<0.001**
VAS	10 (9/10)	1 (0/1)	<0.001
PSQI total score	15 (14/16)	4.5 (3/6)	**<0.001**
Component 1 sleep quality	3 (2/3)	0 (0/1)	**<0.001**
Component 2 sleep latency	1 (1/1)	0 (0/0)	**<0.001**
Component 3 sleep duration	3 (3/3)	3 (3/3)	>0.05
Component 4 sleep efficiency	3 (3/3)	0 (0/1)	<0.001
Component 5 sleep disturbance	2 (2/2)	1 (0/1)	**<0.001**
Component 6 sleep medication	0 (0/1)	0 (0/0)	**<0.001**
Component 7 daytime sleep dysfunction	3 (3/3)	0 (0/0)	**<0.001**

Wilcoxon test was performed. Bonferroni correction was performed for multiple hypothesis testing of PSQI total score. Corrected p-value is “0.05/7=0.007”. VAS: Visual analog scale, IQR: Interquartile range, PSQI: Pittsburgh sleep quality index, EQ-5D-3L: EuroQol 5-dimension questionnaire

Table 3. Comparison of pre- and postoperative changes in VAS, PSQI and EQ-5D-3L scores according to diagnosis of the participants

Diagnosis	EQ-5D-3L change median (IQR1/IQR3)	p-value/ETA^2	PSQI change median (IQR1/IQR3)	p-value/ETA^2	VAS change median (IQR1/IQR3)	p-value/ETA^2
LSS	0.55 (0.28-0.97)	0.008/0.07	-10 [-12-(-8)]	**0.008/0.07**	-8 [-9-(-8)]	**0.004/0.09**
LSL	0.74 (0.39-1.03)		-9 [-12-(-8)]		-8 [-9-(-8)]	
LDH	0.91 (0.58-1.3)		-12 [-13-(-10)]		-9 [-10-(-9)]	

KW test was performed. ETA^2 : Effect size is used for KW test, KW: Kruskal-Wallis, VAS: Visual analog scale, IQR: Interquartile range, PSQI: Pittsburgh sleep quality index, EQ-5D-3L: EuroQol 5-dimension questionnaire, LSS: Lumbar spinal stenosis, LSL: Lumbar spondylolisthesis, LDH: Lumbar disc herniation

Table 4. Comparison of pre- and postoperative changes in VAS, PSQI and EQ-5D-3L scores according to age and gender of the participants

Characteristics	EQ-5D-3L change median (IQR1/IQR3)	p-value	PSQI change median (IQR1/IQR3)	p-value	VAS change median (IQR1/IQR3)	p-value
Age						
1. Below 65	0.88 (0.45/1.12)	0.09	-11 (-12/-8)	0.14	-9 (-10/-8)	**0.02**
2. 65 and above	0.67 (0.28/1.06)		-10 (-11.25/-8)		-8 (-9/-7)	
Gender						
1. Female	0.67 (0.35/0.95)	0.051	-10 (-12/-8)	**0.02**	-9 (-10/-8)	0.85
2. Male	0.90 (0.47/1.34)		-12 (-13/-9.5)		-9 (-10/-8)	

KW and MWU tests were performed. KW: Kruskal-Wallis, MWU: Mann-Whitney U, VAS: Visual analog scale, IQR: Interquartile range, PSQI: Pittsburgh sleep quality index, EQ-5D-3L: EuroQol 5-dimension questionnaire

investigated degenerative spine surgery patients undergoing either decompression alone (without fusion) or posterior decompression with transpedicular instrumented fusion[25,26]. And those who underwent lumbosacral fusion surgery[27] in terms of sleep quality. Distinct from previous investigations, our study included not only LDH and LSS but also LSL, a condition that has not been previously evaluated in relation to sleep quality. Furthermore, unlike earlier studies, we performed a comparative analysis among the three diagnostic groups. Based on our findings, this study provides novel insights and contributes uniquely to the existing literature, with each result discussed individually in detail. In our study, the changes observed in EQ-5D-3L, PSQI, and VAS scores were statistically significant. These results indicate that lumbar surgery is associated with improvements in quality of life and sleep quality, as well as a reduction in pain.

In our study, a significant reduction in VAS scores was observed following surgical intervention in patients with a high prevalence of pain. Similarly, previous studies have also reported a marked decrease in pain levels after surgery[19,22,23,27]. Particularly in cases unresponsive to conservative treatment, lumbar surgery has demonstrated highly favorable outcomes in terms of pain reduction. In the diagnosis-based change analysis, significant within-group postoperative improvements were observed in pain, quality of life, and sleep quality parameters across all surgical groups. However, in the between-diagnosis comparison, the magnitude of postoperative improvement across all three outcome measures was found to be more pronounced in patients with LDH compared with those with LSS and LSL. Although there is no strong evidence in the literature that directly explains this difference, the more pronounced improvement observed in the LDH group may be associated with factors such as a more limited surgical intervention, the minimally invasive nature of posterior decompression, preservation of motion segments due to the absence of fusion, and reduced soft tissue trauma. These interpretations do not imply a causal relationship and should be regarded as potential mechanisms to help explain the observed findings.

In addition, subgroup analysis of patients who underwent posterior decompression for LDH revealed no significant difference between the L4-5 and L5-S1 levels. In our study, it was also determined that as the number of surgical levels increased in LSS, the degree of pain improvement decreased. In a previous study investigating LSS and sleep quality, no significant difference was found in pain reduction according to the number of fused levels when four or more levels were treated[27]. However, in our cohort of 37 patients with LSS who underwent two-, three-, or four-level decompression with posterior transpedicular instrumented fusion, we found that the reduction in VAS scores was more pronounced in patients who underwent two-level fusion compared to those who underwent three-level fusion. In conclusion, our findings suggest that a lower number of fused levels in LSS surgery provides better outcomes in terms of pain control[28].

In the literature, LSL patients have not been specifically evaluated in terms of sleep quality. In our study, however, these patients demonstrated a postoperative decrease in VAS and PSQI scores and an increase in EQ-5D-3L scores. No significant differences were observed with respect to the level (L4-5 vs. L5-S1) or type (degenerative vs. isthmic) of LSL. Our findings indicate that in low-grade LSL patients, surgery leads to improvements in both sleep quality and quality of life, and provides significant benefits in terms of pain relief, particularly in cases unresponsive to conservative treatment. The posterior decompression with transpedicular instrumented fusion technique applied in our series appears to be effective in this patient group, as it restores spinal stability and relieves nerve root compression[24]. Future studies should evaluate LSL patients both preoperatively and postoperatively, focusing on both sleep quality and quality of life. Increasing the sample size, including different types of LSL, comparing various surgical techniques, and extending the follow-up period would contribute to more accurate preoperative patient selection and more effective postoperative care. Moreover, subgroup analyses based on specific surgical techniques could provide valuable insights into optimizing patient outcomes.

When examining gender differences, the reduction in PSQI total scores was greater in men than in women. However, in the study by Lee et al.[23] which analyzed gender subgroups of surgically treated patients in terms of sleep quality, no significant difference was observed.

In our study, 68 patients underwent decompression with posterior transpedicular instrumented fusion and 38 patients underwent alone posterior decompression not instrumented fusion. When studies investigating the relationship between lumbar surgery and sleep quality in the literature are evaluated; Lee et al.[23] reported 63 patients with LSS, although the surgical technique was not specified. Bozduman et al.[27] reported 20 patients with LSS who underwent decompression with posterior transpedicular instrumented fusion. Kim et al.[22] analyzed 48 patients with LSS, of whom 9 underwent posterior decompression (without fusion) and 39 underwent posterior decompression with transpedicular instrumented fusion. Papavero et al.[24] reported 140 patients with LSS who were treated with posterior decompression (without fusion). McNassor et al.[25] reported 349 patients who decompression with transpedicular instrumented fusion and 123 who underwent posterior decompression (without fusion) , with the overall diagnosis described as degenerative spine conditions. In our series, patients who underwent posterior decompression combined with transpedicular instrumented fusion (68 patients) demonstrated greater improvement in sleep quality compared with those who underwent posterior decompression (without fusion) (38 patients). McNassor et al.[25] reported no significant difference in sleep quality improvement between posterior decompression (without fusion) and decompression with posterior transpedicular instrumented fusion, although both groups showed overall improvements. When the findings of both studies are considered together, it appears that the extent of the surgical technique alone does not determine changes in sleep quality. This suggests that sleep quality is a multidimensional parameter influenced by various clinical and individual factors beyond the surgical approach itself.

Study Limitations

Although this study provides important findings regarding the relationship between lumbar surgery, sleep quality, pain reduction, and quality of life, several limitations should be acknowledged. Since only patients with surgical indications were included, a control group could not be established. The follow-up period was limited to 6 months, and longer-term follow-up would help to better assess the durability of surgical outcomes. The single-center design may limit the generalizability of the results.

CONCLUSION

Lumbar surgery provides substantial benefits in terms of pain control, improved sleep quality, and enhanced quality of life, particularly in patients unresponsive to conservative treatment. The most pronounced improvements were observed in LDH cases, while notable postoperative gains were also identified in LSL, which has not previously been evaluated in this context. Overall, in patients with surgical indications who did not benefit from conservative treatment, lumbar surgery consisting of appropriate decompression with additional fusion in the presence of instability was found to be associated with clinically meaningful improvements in patient outcomes.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the Ankara Yıldırım Beyazıt University (approval no: 10-497, date: 19.12.2023).

Informed Consent: Prospective pre-post design.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.T., Ö.F.Ş., H.İ.A., Concept: B.T., E.Ü., Design: B.T., E.Ü., E.A., Data Collection or Processing: B.T., E.A., Ü.G., H.İ.A., Analysis or Interpretation: E.Ü., E.A., Ü.G., Literature Search: B.T., E.Ü., E.A., Writing: B.T., E.Ü., Ö.F.Ş.

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