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ORIGINAL STUDIES

Central sensitization as a predictor of short-term postoperative outcomes in lumbar spinal stenosis: a prospective observational study

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Abstract

Purpose Central sensitization (CS) has been increasingly recognized as a key factor influencing pain perception and recovery in degenerative spinal disorders. This study aimed to investigate whether preoperative CS predicts postoperative outcomes in patients undergoing decompression surgery for lumbar spinal stenosis (LSS).

Methods Eighty-six patients with LSS who underwent decompression surgery were prospectively evaluated. CS was assessed using the Central Sensitization Inventory (CSI), with a cutoff score of ≥40 defining CS. Visual analogue scale (VAS) pain, Oswestry Disability Index (ODI), Hospital Anxiety and Depression Scale (HADS), and the 12-Item Short Form Health Survey (SF-12) were recorded preoperatively and at three months. Between-group comparisons and multivariate regression analyses were performed to determine the independent effect of CS on postoperative improvement.

Results Patients with CS (54.7%) reported significantly greater baseline pain, disability, and anxiety (all $p<0.05$). Although both groups improved postoperatively, the magnitude of improvement was smaller in CS+ patients. Between-group differences were significant for reductions in low back pain ($p=0.038$), leg pain ($p=0.003$), numbness ($p=0.001$), disability ($p<0.001$), and physical quality of life ($p<0.001$). Regression analyses found that CS independently predicted poorer improvement in disability ($\beta = +22.7$, $p<0.001$), pain ($\beta = +2.3$, $p<0.001$), and physical function ($\beta = -12.4$, $p<0.001$), explaining up to 42% of the variance in postoperative outcomes.

Conclusion Preoperative CS is independently associated with less favorable short-term postoperative recovery following lumbar decompression for LSS. Routine assessment of CS may help identify patients at risk for suboptimal outcomes and guide individualized perioperative management.

Keywords Central sensitization · Spinal stenosis · Surgical outcomes · Pain

Introduction

Lumbar spinal stenosis (LSS) is a common degenerative condition in older adults characterized by narrowing of the spinal canal [1]. This causes chronic pain, disability, and reduced quality of life [1]. The diagnosis is typically based on a history of back and leg pain that worsens with prolonged standing or walking and improves with sitting, supported by cross-sectional imaging such as MRI or CT [2]. It is a common condition, affecting more than 100 million people globally and around 11% of older adults in the US [3]. Initial management focuses on conservative measures including physical therapy, analgesics, and lifestyle modification. For patients who continue to experience significant pain or functional impairment despite conservative treatment, surgical decompression can offer substantial symptom improvement and enhanced quality of life [1, 2].

Surgical decompression for LSS is generally effective in relieving neurogenic claudication and improving function in most patients. Long-term studies have demonstrated sustained clinical benefit, with a majority of patients reporting significant pain reduction and functional recovery following surgery [4]. However, surgical failure is not uncommon.

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Approximately one-third of patients may experience unsatisfactory outcomes, including persistent pain or disability despite surgical decompression [5, 6]. Predictors of poor surgical results include advanced age, prolonged symptom duration, greater baseline disability, predominant back pain rather than leg pain, and depression [5, 7]. However, these factors explain only part of the variability in postoperative recovery, suggesting that other neurophysiological mechanisms may contribute to residual symptoms after surgery.

One such mechanism is central sensitization (CS), defined as an increased responsiveness of nociceptive neurons in the central nervous system to normal or subthreshold afferent input [8]. Clinically, CS is characterized by hyperalgesia, allodynia, and disproportionate pain in the absence of ongoing tissue damage [9]. It has been increasingly recognized as a key factor in chronic musculoskeletal pain conditions such as osteoarthritis, fibromyalgia, and chronic low back pain (LBP) [10, 11]. In patients with LSS, chronic nociceptive input from degenerated structures and prolonged neural compression may induce maladaptive neuroplastic changes, leading to CS and persistent pain even after adequate decompression [8, 9]. Recent evidence indicates that the clinical manifestations of LSS cannot be fully explained by mechanical compression alone. In a study of 154 patients with LSS, radiological parameters showed no significant correlation with pain intensity or disability, whereas CS–related symptoms and psychosocial factors demonstrated weak but statistically significant associations with LBP and functional limitation [12]. Specifically, higher Central Sensitization Inventory (CSI) scores and elevated pain catastrophizing were independently related to greater pain and disability, suggesting that central and psychological mechanisms contribute more to clinical symptom severity than morphological narrowing of the spinal canal. These findings reinforce the concept that LSS is a multidimensional disorder in which peripheral, central, and psychosocial factors interact to shape the patient's pain experience. Additionally, neurophysiological evidence suggests that a subset of patients with chronic spinal pain develop CS characterized by altered pain modulation and widespread hyperalgesia [13]. This mechanism may explain why some individuals with LSS continue to experience severe pain and disability disproportionate to the degree of neural compression, and even persistent symptoms after successful decompression surgery.

Despite growing evidence, the independent contribution of CS to short-term postoperative recovery in LSS remains insufficiently explored. Therefore, this study aimed to determine whether preoperative CS independently predicts postoperative improvement in pain, disability, and quality of life among patients undergoing surgery for LSS. We hypothesized that patients with CS would show significantly less postoperative improvement even after adjusting for demographic and clinical covariates.

Methods

Design and study population

This prospective observational study was conducted at the Departments of Neurosurgery and Physical Medicine and Rehabilitation, Karadeniz Technical University Faculty of Medicine, between January 2024 and June 2025. Patients diagnosed with degenerative lumbar spinal stenosis (LSS) and scheduled for decompression surgery were consecutively recruited. The diagnosis of LSS was established based on clinical symptoms (neurogenic claudication and/or radicular leg pain) and radiological confirmation of spinal canal narrowing on MRI.

Inclusion criteria were: diagnosis of degenerative LSS with corresponding clinical and imaging findings, and completion of both preoperative and 3-month postoperative evaluations. An age cut-off of 40 years was selected to capture the full clinical spectrum of degenerative lumbar spinal stenosis, including patients with early-onset degenerative changes who present in routine clinical practice. While registry-based studies often use a higher age threshold, our aim was to reflect real-world surgical populations rather than restrict inclusion to older age groups alone. Exclusion criteria included previous lumbar surgery, spondylolisthesis grade $\geq$ II, spinal infection or tumor, inflammatory spondyloarthropathy, peripheral neuropathy, psychiatric or cognitive disorders interfering with questionnaire completion, and chronic opioid use.

All participants provided written informed consent. The study protocol was approved by the Institutional Ethics Committee (Approval No: 2025/95) and conducted in accordance with the Declaration of Helsinki.

Clinical assessments and outcome measures

Demographic and clinical data included age, sex, body mass index (BMI), education level, marital and working status, and disease duration (months). Disease duration was defined as the duration of leg symptoms consistent with neurogenic claudication, as reported by the patient at the time of preoperative assessment. Pain intensity for both LBP, leg pain, and numbness was evaluated using the Visual Analog Scale (VAS) (0–10). The Oswestry Disability Index (ODI) was used to evaluate functional disability related to LBP. It is a validated, disease-specific questionnaire consisting of 10 items covering domains such as pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life,

and traveling. The total score is expressed as a percentage of the maximum possible score, with higher scores indicating greater disability [14]. The 12-Item Short Form Health Survey (SF-12) was used to assess health-related quality of life. It includes physical and mental component summary scores with higher scores indicating better quality of life [15]. Psychological status was evaluated using the Hospital Anxiety and Depression Scale (HADS). Originally developed for use in medical outpatient settings, the HADS consists of 14 items; 7 assessing anxiety (HADS-A) and 7 assessing depression (HADS-D). Higher scores indicate greater levels of anxiety and depressive symptoms [16]. The participants completed clinical outcome assessments preoperatively and 3 months postoperatively.

Central sensitization was assessed using the CSI, a validated self-report questionnaire designed to identify CS-related symptoms across chronic pain syndromes. The CSI comprises 25 items scored on a 5-point Likert scale (0–4), producing a total score between 0 and 100. A cutoff score of ≥ 40 was used to define the presence of CS, consistent with the original validation study by Mayer et al. [17].

The CSI was assessed preoperatively to characterize baseline pain-related vulnerability. Patients were classified into CS + and CS− groups, and comparative analyses were performed to examine differences in pre- and postoperative outcomes. Postoperative CSI assessment was not performed, as the CSI has primarily been validated as a trait-like measure rather than a tool sensitive to short-term postoperative change. In addition, early postoperative CSI scores may be confounded by acute surgical pain and recovery-related factors.

Surgical procedure and follow-up

All patients underwent lumbar decompression for symptomatic lumbar spinal stenosis performed by the same surgical team. Discectomy was performed only in cases where focal disc protrusion or sequestration contributed to neural compression in addition to degenerative canal narrowing, which is a frequent accompanying finding in lumbar spinal stenosis. Fusion was selectively applied in patients with radiological or intraoperative evidence of segmental instability, in accordance with standard surgical indications. Postoperative follow-up evaluations were conducted 3 months after surgery by an independent, blinded assessor who was not involved in the surgical procedures.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA) and Python (Statsmodels v0.14). Data distribution was evaluated using Shapiro–Wilk. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as frequencies and percentages.

Between-group differences were analyzed using t-tests or Mann–Whitney U tests, and chi-square tests for categorical variables. Within-group changes were analyzed using paired-samples t-tests.

To determine whether CS independently predicted postoperative outcomes, multiple linear regression analyses were conducted for ΔODI, ΔVAS-LBP, and ΔSF-12-PCS as dependent variables. Independent variables included CS status, age, sex, BMI, disease duration, and corresponding baseline scores. Not all baseline patient-reported outcome measures were entered simultaneously into each multivariable model. Independent variables were selected based on clinical relevance to the specific postoperative outcome being analyzed and to avoid model overfitting. CS status was included in all multivariable models as the primary variable of interest. Effect size was expressed as Cohen's f^2, and model fit was evaluated by adjusted R^2. Post-hoc power analyses ($\alpha = 0.05$) were performed for each model. The change in the coefficient of determination (ΔR^2) represents the incremental variance explained by adding CS status to the multivariable model. Specifically, ΔR^2 was calculated as the difference in R^2 between the base model including relevant covariates and the extended model after inclusion of CS.

A p-value < 0.05 was considered statistically significant.

Results

A total of 92 patients met the inclusion criteria and were enrolled in the study. Of these, 86 patients (93.5%) completed both the preoperative and 3-month postoperative evaluations, while 6 patients (6.5%) were lost to follow-up. Given the low rate of loss to follow-up, only patients with complete preoperative and postoperative data were included in the final analysis. No data imputation was performed. Eighty-six patients were included; 47 (54.7%) were classified as having CS (CS+) and 39 (45.3%) as not having CS (CS-) according to the CSI.

Baseline demographics demonstrated no group differences in terms of age, BMI, or disease duration. However, the proportion of females was significantly higher in the CS+ group (82% vs. 46%, $p < 0.001$), and employment status differed significantly, with a greater proportion of housewives or non-working individuals among CS+ patients ($p = 0.001$) (Table 1).

Table 1 Baseline demographic characteristics of the patients

	Total ($n=86$)	With CS ($n=47$)	Without CS ($n=39$)	p value
Age (yr), mean (±SD)	62.76±11.61	62.60±12.55	62.95±10.51	0.889
Female sex, n(%)	57(66)	39(82)	18(46)	<0.001
BMI (mean±SD)	31.92±5.17	31.42±4.13	32.46±6.24	0.357
Marital Status, n(%) • married • single/ divorced	78(90) 8(10)	40(85) 7(15)	38(97) 1(3)	0.067
Working status, n(%) • working • retired • housewife/ not working	10(11) 23(27) 53(62)	4(9) 6(12) 37(79)	6(15) 17(44) 16(41)	0.001
Education Status, n(%) • primary school • middle/high school • university	25(29) 44(51) 17(20)	15(32) 26(56) 6(12)	10(26) 18(46) 11(28)	0.201
Disease duration, years	5.62±4.57	5.45±4.52	5.82±4.69	0.708

CS, central sensitization; BMI, body mass index

Table 2 Baseline clinical parameters of the patients

	Total ($n=86$)	With CS ($n=47$)	Without CS ($n=39$)	p value
VAS-LBP	7.62±2.21	8.57±1.82	6.46±2.10	<0.001
VAS-Leg pain	7.99±1.94	8.70±1.74	7.13±1.82	<0.001
VAS-Numbness	7.56±2.15	8.36±1.95	6.59±1.98	<0.001
CSI score	38.62±14.81	49.66±8.43	25.31±8.46	<0.001
ODI score	65.35±18.10	72.38±16.44	56.87±16.45	<0.001
HADS-anxiety	11.34±3.28	12.55±3.50	9.87±2.28	<0.001
HADS-depression	9.49±1.49	9.81±1.58	9.10±1.27	0.027
SF-12 Physical health	32.49±6.26	30.43±3.88	34.97±7.60	0.001
SF-12 Mental health	53.06±8.52	49.91±7.81	56.85±7.83	<0.001

CS, central sensitization; VAS, Visual analog scale; LBP, Low back pain; ODI, Oswestry disability index; HADS, Hospital anxiety depression scale; SF-12, Short form-12

Baseline clinical parameters

Baseline clinical findings (Table 2) revealed that CS+ patients had significantly higher LBP, leg pain, and numbness scores. Disability levels were markedly higher in the CS+ group ($p<0.001$), while SF-12 physical and mental component scores were significantly lower ($p<0.001$ for both). In addition, CS+ patients reported higher anxiety ($p<0.001$) and depression scores ($p=0.027$), indicating greater psychological distress at baseline.

Table 3 Preoperative and postoperative clinical outcomes in patients with and without CS

		With CS ($n=47$)	p value	Without CS ($n=39$)	p value
VAS-LBP	Pre-op	8.57±1.82	0.044	6.46±2.10	0.027
	Post-op	5.34±1.60		2.31±1.00	
VAS-Leg pain	Pre-op	8.70±1.74	0.055	7.13±1.82	0.021
	Post-op	5.49±1.58		2.67±1.24	
VAS-Numbness	Pre-op	8.36±1.95	0.029	6.59±1.98	0.025
	Post-op	5.43±1.59		2.23±0.98	
ODI score	Pre-op	72.38±16.44	<0.001	56.87±16.45	<0.001
	Post-op	50.89±14.17		19.31±8.88	
HADS-anxiety	Pre-op	12.55±3.50	0.002	9.87±2.28	0.001
	Post-op	9.26±2.72		7.97±1.53	
HADS-depression	Pre-op	9.81±1.58	0.006	9.10±1.27	<0.001
	Post-op	8.45±1.11		7.90±1.44	
SF-12 Physical health	Pre-op	30.43±3.88	0.001	34.97±7.60	<0.001
	Post-op	39.94±6.61		54.95±7.92	
SF-12 Mental health	Pre-op	49.91±7.81	0.850	56.85±7.83	0.269
	Post-op	58.60±5.76		63.95±12.01	

CS, central sensitization; VAS, Visual analog scale; LBP, Low back pain; ODI, Oswestry disability index; HADS, Hospital anxiety depression scale; SF-12, Short form-12

Table 4 Between-group comparison of postoperative improvement (Δ values)

	With CS ($n=47$) Mean±SD	Without CS ($n=39$) Mean±SD	p value
Δ VAS-LBP	−3.23±2.04	−4.15±1.98	0.038
Δ VAS-Leg pain	−3.21±1.99	−4.46±1.79	0.003
Δ VAS-Numbness	−2.94±2.08	−4.36±1.87	0.001
Δ ODI score	−21.49±12.91	−37.56±11.80	<0.001
Δ HADS-anxiety	−3.36±3.30	−1.97±1.90	0.025
Δ HADS-depression	−1.36±1.53	−1.21±1.10	0.596
Δ SF-12 Physical health	9.51±5.91	19.97±7.50	<0.001
Δ SF-12 Mental health	8.68±9.84	7.10±13.09	0.526

CS, central sensitization; SD, standard deviation; VAS, Visual analog scale; LBP, Low back pain; ODI, Oswestry disability index; HADS, Hospital anxiety depression scale; SF-12, Short form-12

Postoperative changes within and between groups

Both groups demonstrated significant postoperative improvements in pain, disability, and quality of life (Table 3). However, the magnitude of improvement was consistently smaller in the CS+ group compared with the CS- group (Table 4). Between-group comparisons of change scores revealed that patients with CS experienced smaller decreases in LBP ($p=0.038$), leg pain ($p=0.003$), and numbness ($p=0.001$). Improvement in disability was substantially less pronounced in the CS+ group ($p<0.001$),

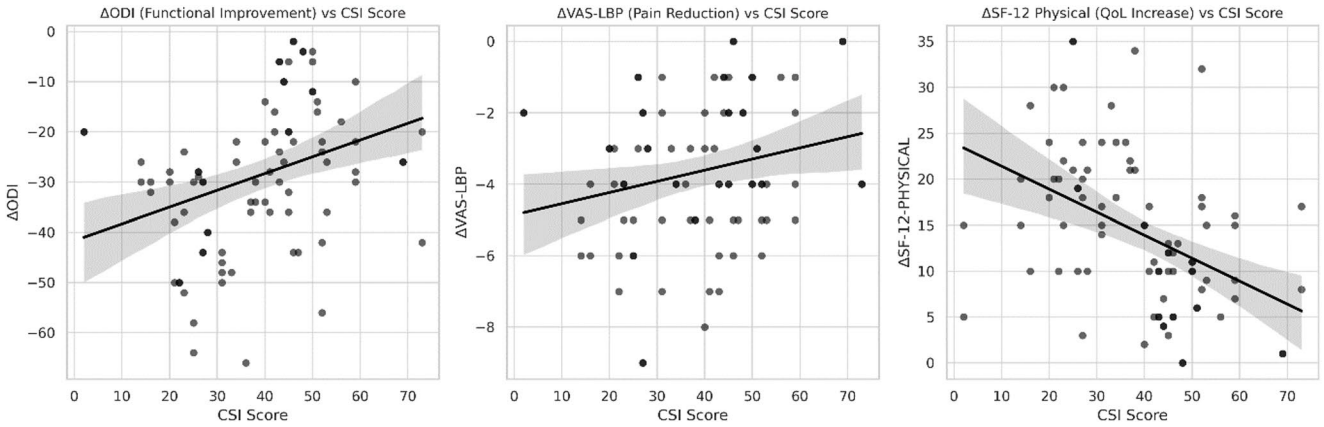


Fig. 1 Correlations between CSI scores and postoperative changes. Scatter plots showing the associations between preoperative CSI scores and postoperative improvements in ODI, (B) VAS for low back pain, and SF-12. Higher CSI scores were associated with smaller postoperative gains, indicating poorer surgical recovery

Table 5 Multiple linear regression analyses showing the independent effect of CS on postoperative improvement

Outcome Variable	β (CS^+ vs. CS^-)	95% CI for β	*p* value	Adjusted R^2	ΔR^2 (adding CS)	Cohen's f^2 (partial)	Post-hoc Power (α = 0.05)
ΔODI (Functional improvement)	+22.73	18.07 to 27.38	< 0.001	0.65	0.424	1.20	1.00
ΔVAS-LBP (Pain reduction)	+2.28	1.58 to 2.98	< 0.001	0.63	0.196	0.53	1.00
ΔSF-12 Physical (Quality of life)	−12.43	−15.64 to −9.23	< 0.001	0.46	0.407	0.75	1.00

Model adjusted for: age, sex, BMI, disease duration, and corresponding preoperative scores (ODI, VAS-LBP, SF-12 Physical)

Interpretation: Positive β indicates less improvement (worse outcome) in CS^+ group; negative β indicates smaller gain in quality of life

CS, central sensitization; ODI, Oswestry Disability Index; VAS, Visual Analog Scale; SF-12, 12-Item Short Form; CI, confidence interval

as was the increase in physical quality-of-life scores ($p < 0.001$). Differences in depression and mental health changes between groups were not statistically significant ($p = 0.596$ and $p = 0.526$, respectively).

Correlation analyses

Continuous CSI scores were strongly correlated with the amount of postoperative improvement (Fig. 1). Higher CSI values were associated with smaller reductions in ODI ($r = -0.61$, 95% CI −0.57 to −0.22), VAS-LBP ($r = -0.49$, 95% CI −0.01 to −0.42), and smaller increases in SF-12 Physical scores ($r = 0.57$, 95% CI 0.32 to 0.64), all $p < 0.001$, confirming that higher levels of CS predicted poorer surgical recovery.

Multivariate regression analysis

Multivariate regression analyses (Table 5) demonstrated that CS independently predicted postoperative outcomes even after adjusting for demographic and baseline clinical variables. CS was associated with significantly less improvement in disability (β = +22.73, $p < 0.001$), less reduction in LBP (β = +2.28, $p < 0.001$), and smaller gains in physical quality of life (β = −12.43, $p < 0.001$). CS explained an additional 19–42% of the variance across models, with large effect sizes (Cohen's f^2 = 0.53–1.20). The apparent difference between the unadjusted group-level change in ODI and the regression coefficient reflects the distinction between crude comparisons and adjusted analyses. While the unadjusted analysis compares mean ODI change between CS groups, the multivariable regression coefficient represents the independent association of CS with postoperative ODI change after adjusting for baseline disability and other relevant covariates. Accordingly, the regression coefficient may differ in magnitude from the unadjusted mean difference.

Discussion

This prospective study demonstrated that preoperative CS is a strong and independent predictor of limited postoperative improvement in pain, disability, and physical quality of life following decompression surgery for LSS. Although all patients improved postoperatively, those with CS achieved significantly smaller gains. CS accounted for up to 42% of postoperative outcome variance, underscoring its clinical relevance in surgical prognostication.

Our findings are consistent with previous research highlighting the prognostic role of CS in degenerative lumbar disorders. Akeda et al. [18] reported that higher preoperative CSI scores were significantly associated with worse postoperative pain and disability after decompression for LSS, independent of age, sex, and baseline disability. Bennett et al. [19] demonstrated that higher preoperative CSI scores predicted worse postoperative quality-of-life measures and prolonged hospital stays following spinal fusion surgery. Their results underscore that the influence of CS extends beyond pain perception to encompass global recovery parameters and healthcare utilization. A recent study by Ashida et al. [12] investigated the relative influence of radiological, psychosocial, and CS–related factors on clinical symptoms in 154 patients with LSS, and reported that radiological parameters were not significantly correlated with pain intensity or disability, whereas higher CSI and pain catastrophizing scores were independently associated with worse ODI scores. These results suggest that symptom severity in LSS cannot be fully explained by the degree of canal narrowing, but rather by the contribution of central and psychosocial mechanisms. In addition, Ogon et al. [20] demonstrated that greater visceral fat accumulation and systemic inflammation were associated with higher CSI scores and chronic pain severity in patients with LSS, suggesting that metabolic and inflammatory factors may further exacerbate CS and contribute to persistent postoperative symptoms. Collectively, these studies highlight the multifactorial nature of LSS, where structural, metabolic, and psychosocial elements converge to influence symptom burden. However, while prior research has primarily focused on preoperative associations, our findings extend this evidence by demonstrating that preoperative CS is independently associated with less favorable postoperative recovery following lumbar decompression. Importantly, CS was assessed only preoperatively in this study, and no conclusions regarding postoperative changes in CS can be drawn.

The findings of Yamada et al. [21] provide an important contrast to our results. In their cohort of patients undergoing lumbar discectomy for acute disc herniation, preoperative CS was associated with greater baseline pain and disability but did not independently predict postoperative improvement. This discrepancy may be explained by differences in disease chronicity and underlying pathophysiology. The relationship between spinal pathology and CS is complex and not solely determined by the duration or mechanical nature of neural compression. Disc herniation is well known to induce a pronounced inflammatory response, which may substantially contribute to the development of CS. In contrast, LSS is characterized by a chronic and multifactorial process involving mechanical compression, ischemia, and low-grade inflammation, which may also predispose patients to heightened pain-related vulnerability. A recent systematic review and meta-analysis demonstrated that CSI more closely reflects psychological hypervigilance than increased responsiveness of nociceptive neurons [22]. Accordingly, the present findings should be interpreted as reflecting the impact of heightened pain-related vulnerability on postoperative recovery, rather than persistent neurophysiological sensitization per se.

From a clinical perspective, these findings highlight the importance of incorporating CS assessment into the preoperative evaluation of patients with LSS. Routine screening with tools such as the CSI can help identify individuals at risk of poor surgical outcomes and inform more individualized perioperative management. Multimodal interventions targeting both peripheral and central pain mechanisms, such as cognitive behavior therapy, pain neuroscience education, graded exercise, and pharmacologic modulation using antidepressants or gabapentinoids, have shown efficacy in reducing CS-related pain hypersensitivity [23–26]. Recent advances in pain neuroscience have emphasized the importance of identifying CS phenotypes as part of a precision medicine approach to chronic pain management. Nijs et al. [27] proposed that individualized assessment of CS could guide targeted therapeutic strategies aimed at restoring endogenous pain inhibition and modulating neuroimmune dysregulation. Our findings support this concept by showing that preoperative CS screening provides valuable prognostic information and may help tailor perioperative interventions to optimize recovery in patients with LSS.

Gender differences in CS may also be relevant when interpreting the present findings. Consistent with our findings, a cross-sectional study across different chronic musculoskeletal pain populations reported significantly higher CS scores in female patients, supporting the notion that sex-related factors contribute to pain-related vulnerability independent of specific diagnosis [28]. In the current cohort, the distribution of gender differed between CS groups, which may have contributed to differences in postoperative recovery patterns. However, the present study was not designed to specifically evaluate sex-based differences in CS or surgical outcomes, and these observations should therefore be interpreted with caution. Future studies with larger sample sizes are warranted to explore potential sex-specific mechanisms underlying CS and postoperative outcomes in LSS.

Limitations

This study has several limitations. It was conducted at a single center with a relatively modest sample size, which may limit the generalizability of the findings. CS was evaluated using the self-reported CSI rather than quantitative sensory testing (QST) or neurophysiological markers. Although the

CSI is widely validated and practical for clinical use, it may be influenced by subjective bias. CS was assessed only preoperatively, and postoperative changes in CSI could not be evaluated, which limits conclusions regarding the temporal evolution of CS after surgery. In addition, the follow-up period was restricted to three months, capturing early postoperative recovery but not long-term outcomes. Future studies with extended follow-up are needed to determine whether the observed associations persist over time.

Psychosocial variables such as catastrophizing and coping styles were not separately quantified, which might further clarify the interrelationship between CS and psychological factors. Moreover, certain potential confounders, such as smoking status and physical comorbidities were not systematically assessed, which may have influenced postoperative outcomes. Baseline patient-reported outcome measure scores in the present cohort were higher than those reported in national spinal registries. This likely reflects a more symptomatic, treatment-refractory surgical population treated at a tertiary referral center. Consequently, the findings may be less generalizable to broader LSS populations, particularly those with milder symptoms managed non-operatively.

Despite these limitations, the prospective design, comprehensive assessment of functional and psychological outcomes, and rigorous statistical analyses strengthen the validity of our findings.

Conclusions

Preoperative CS, assessed by the CSI, independently predicted poorer short-term postoperative improvement in pain, disability, and physical quality of life after decompression surgery for LSS. These findings suggest that CS contributes to persistent symptoms despite technically successful surgery. Routine CS screening can help identify patients at risk for suboptimal outcomes and support more individualized, multimodal perioperative management strategies.

Author contributions HBŞ: Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Visualization; Writing- original draftMA: Data curation; Supervision; Validation; writing – review & editing, supervision.All authors have read and approved the final manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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