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Associations of Self-Compassion and Psychological Factors with Short-Term Outcomes Following Dorsal Root Ganglion-Targeted Interventional Treatment

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Abstract

Background/Objectives: Clinical outcomes following interventional treatment for lumbar pain vary considerably, and psychological factors may contribute to this variability. Although self-compassion has been associated with better adjustment to chronic pain, its association with outcomes following interventional pain management remains unclear. This study examined the association between preprocedural self-compassion and short-term changes in pain intensity and functional disability following dorsal root ganglion (DRG)-targeted interventional treatment. **Methods:** This single-centre retrospective secondary analysis included 100 patients who underwent DRG-targeted interventional treatment for chronic lumbar pain and had complete baseline and 1-month follow-up data. Pain intensity, disability, self-compassion, resilience, psychological well-being, depressive symptoms, and anxiety symptoms were assessed using validated measures. Baseline-adjusted multivariable regression models were used to examine associations between preprocedural self-compassion and 1-month VAS and ODI outcomes. **Results:** The final analytic sample included 100 patients. Mean VAS scores decreased from 7.94 ± 1.08 at baseline to 4.48 ± 2.24 at 1 month, and mean ODI scores decreased from 60.22 ± 16.44 to 38.18 ± 20.60 (both $p < 0.001$). In baseline-adjusted multivariable models, higher preprocedural self-compassion was independently associated with lower 1-month pain intensity (B = −0.185, 95% CI [−0.228, −0.142], $p < 0.001$) and lower disability (B = −1.417, 95% CI [−1.709, −1.126], $p < 0.001$) after adjustment for age, sex, procedure category, depressive symptoms, anxiety symptoms, and the corresponding baseline outcome. **Conclusions:** Higher preprocedural self-compassion was independently associated with more favorable short-term pain and disability outcomes following DRG-targeted treatment. However, because this was an uncontrolled, single-centre observational study, the findings do not establish treatment efficacy, causal effects, or individual prognostic performance. Further prospective multicentre studies are needed to confirm these associations.

Keywords: self-compassion; lumbar pain; dorsal root ganglion; chronic pain

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1. Introduction

Low back pain is one of the leading causes of disability worldwide and imposes a substantial societal and economic burden through healthcare utilization and loss of productivity [1,2]. The presence of radicular pain in patients with low back pain may be associated with greater pain intensity and functional disability [2]. The development and persistence of chronic radicular pain are not solely related to the underlying structural pathology but are shaped by the interplay of neuroinflammatory and neuropathic processes, alterations in central pain processing mechanisms, and psychosocial factors [3,4]. Therefore, evaluating chronic low back pain solely in terms of structural pathology may be insufficient; consideration of biological, psychological, and social factors together provides a more comprehensive clinical approach [3,5].

In patients with lumbar radicular pain whose symptoms persist despite conservative treatments, interventional procedures targeting the nerve root and dorsal root ganglion (DRG), which are involved in pain transmission, are used [6–8]. The DRG, which contains the cell bodies of primary afferent neurons, plays an important role in the transmission and modulation of sensory and nociceptive information from the periphery to the central nervous system [4,6]. Following nerve root injury or compression, ectopic activity, changes in ion channel expression, and local neuroinflammatory processes at the DRG may contribute to the development and persistence of radicular neuropathic pain [4,7]. These pathophysiological features make the DRG an important target for interventional pain management [6,8].

Nevertheless, clinical responses may vary considerably among patients even after appropriately performed targeted spinal interventions [8,9]. Karlsson et al. reported that 44% of patients achieved at least a 30% reduction in pain intensity at 14 days following selective nerve root blockade, with treatment responders also demonstrating significant improvements in psychological and other patient-reported outcomes [9]. Similarly, evidence suggests that treatment response to targeted spinal interventions may not be explained solely by anatomical and procedural factors [8,9]. Psychological factors such as depression, anxiety, and pain catastrophizing have been considered potential contributors to these differences in treatment response [3,5,10]. These factors have been associated with greater pain intensity, increased functional disability, and poorer clinical outcomes in adaptation to chronic pain [5,10,11]. Bahar-Ozdemir et al. reported weak negative correlations between depression levels and pain reduction following lumbar transforaminal epidural steroid injection, but found no significant differences in depression, anxiety, or somatization levels between patients with successful and unsuccessful treatment outcomes [12]. These findings highlight the complexity of the relationship between psychological characteristics and clinical outcomes following interventional pain treatments and suggest that, in addition to psychological distress, protective psychological resources that may facilitate coping and adaptation to pain also warrant investigation.

One such protective psychological construct is self-compassion, which refers to responding to oneself with understanding rather than excessive self-criticism during times of difficulty, recognizing one's experiences as part of the shared human experience, and approaching negative thoughts and emotions with balanced awareness rather than over-identification [13–15]. Higher levels of self-compassion have been associated with lower negative affect, more adaptive emotion regulation, and more balanced physiological responses to stress [14,16,17]. Among individuals with chronic musculoskeletal pain, higher self-compassion has also been associated with less pain catastrophizing and functional impairment, as well as better psychological adjustment [18,19].

Although interest in the potential role of self-compassion in chronic low back pain has increased, evidence in this area remains limited, and most existing studies have focused

on self-compassion-based psychological interventions [19,20]. Other adaptive psychological characteristics, such as resilience, defined as the capacity to recover from stress and adversity [21], and psychological well-being, which encompasses meaning and purpose in life, competence, and positive psychological functioning [22], may also be relevant to adaptation to chronic pain. However, data examining whether these protective psychological characteristics are associated with pain and functional outcomes following DRG-targeted interventional treatments, independently of negative affective variables such as depression and anxiety, remain limited.

The primary aim of this study was to examine the association between preprocedural self-compassion and 1-month changes in pain intensity and functional disability following DRG-targeted intervention in patients with chronic lumbar radicular pain. We also evaluated whether this association persisted after adjustment for baseline clinical severity, demographic and procedural characteristics, and depressive and anxiety symptoms, while exploring the associations of other psychological factors with clinical outcomes. We hypothesized that higher baseline self-compassion would be associated with greater improvements in pain and functional disability at 1 month.

2. Materials and Methods

2.1. Participants

This study was a retrospective secondary analysis of routinely collected clinical records of adult patients who underwent DRG-targeted interventional treatment for lumbar radicular pain at the Pain Management Clinic of Sisli Hamidiye Etfal Training and Research Hospital between January and December 2025. Clinical and psychometric assessments were performed as part of routine clinical care and follow-up and were not collected prospectively for the purposes of the present study. Written informed consent was obtained for the interventional procedure as part of routine clinical care. The present study was subsequently designed as a retrospective secondary analysis of these existing clinical records. Ethical approval for the retrospective use and analysis of the data was obtained from the Clinical Research Ethics Committee of Sisli Hamidiye Etfal Training and Research Hospital on 2 June 2026 (protocol no. 5553). No study-specific data extraction or analysis was performed before this approval was obtained.

Clinical records of patients who underwent the relevant DRG-targeted procedure during the defined study period were screened according to the eligibility criteria. This screening identified 112 potentially eligible records. Of these, 8 were excluded because 1-month follow-up data were unavailable and 4 because baseline assessments were incomplete, leaving 100 patients in the final analytic sample. Because inclusion in the analytic cohort required availability of both baseline and 1-month assessments, the final analysis represents a complete-record sample. No statistical imputation was performed.

The mean age of the patients was 48.10 years (SD = 12.27), and 51% were male. The inclusion criteria were as follows: (1) age between 18 and 65 years; (2) chronic lumbar radicular pain persisting for at least three months and radiating to the lower extremity in a dermatomal distribution; (3) lumbar magnetic resonance imaging (MRI) findings consistent with the clinical examination, demonstrating nerve root pathology such as disc herniation, foraminal stenosis, or lateral recess stenosis; (4) persistent pain and functional limitations despite conservative treatment, including analgesic medications and physical therapy; (5) ability to understand and complete the clinical questionnaires administered as part of routine clinical care; and (6) availability of both baseline and 1-month follow-up assessments in the clinical records.

The exclusion criteria were as follows: (1) cognitive impairment or intellectual disability preventing valid completion of the questionnaires; (2) severe psychiatric or neurological

disorders interfering with clinical assessment; (3) inability to provide informed consent for the clinical procedure; (4) incomplete baseline or 1-month follow-up data; and (5) severe or progressive neurological compression, active infection, uncorrected coagulopathy, or any condition requiring priority surgical evaluation.

2.2. Procedure

All patients were placed in the prone position on the procedure table. The skin at the intervention site was disinfected three times with povidone–iodine solution, followed by sterile draping. No sedation was administered during the procedures. Under fluoroscopic guidance, the intervertebral foramen corresponding to the targeted lumbar nerve root was identified. Local anesthesia was achieved by infiltrating the needle entry site with 2 mL of 1% lidocaine. Subsequently, a 10 cm radiofrequency cannula with a 5 mm active tip was advanced toward the dorsal root ganglion (DRG) of the targeted lumbar nerve root under intermittent fluoroscopic guidance.

Appropriate needle positioning was assessed using sensory and motor stimulation. Sensory stimulation elicited responses concordant with the patient's presenting pain symptoms, while motor stimulation produced multifidus muscle contraction, further supporting appropriate needle placement. Subsequently, 2 mL of iohexol contrast medium was injected under fluoroscopic guidance to confirm appropriate needle tip positioning within the epidural space and to exclude intravascular contrast spread. Following confirmation of appropriate needle placement, pulsed radiofrequency (PRF) (2 Hz, 20 ms) (TOP Corporation, Tokyo, Japan) treatment was applied to the targeted DRG at 42 °C for 180 s. After PRF application, the needle was directed toward the targeted nerve root, and a total of 5 mL of injectate containing 8 mg of dexamethasone (2 mL), 1.5 mL of 0.5% bupivacaine, and 1.5 mL of 0.9% normal saline was administered as a transforaminal epidural steroid injection.

All patients underwent a single session of combined DRG-targeted PRF and steroid injection, with no repeat interventional procedures performed during the one-month follow-up period. No complications were observed during or immediately after the procedures. Patients were discharged in stable clinical condition, with a follow-up assessment scheduled one month after the intervention. During the one-month follow-up period, no additional interventional procedures were performed or new treatments initiated, while patients continued their pre-existing treatments without modification. At the one-month follow-up visit, pain intensity and functional status were reassessed and compared with baseline measurements.

Interventional procedures were performed according to the clinical indication and the anatomical level considered responsible for the patient's lumbar pain. Procedures targeted the dorsal root ganglion at the relevant lumbar or sacral level. The most frequently treated levels were S1 (n = 34, 34%), L5 (n = 32, 32%), combined L5–S1 (n = 18, 18%), L4–5 (n = 8, 8%), L3–4 (n = 5, 5%), and L4 DRG (n = 3, 3%).

Baseline clinical and psychometric assessments, including pain intensity, pain-related disability, self-compassion, resilience, psychological well-being, anxiety, and depressive symptoms, had been completed in paper-and-pencil format before the intervention as part of routine clinical care, and VAS and ODI scores recorded at the routine 1-month follow-up visit were retrieved from the clinical records.

2.3. Measurements

2.3.1. Flourishing Scale (FS)

Psychological well-being was assessed using the Flourishing Scale developed by Diener et al. The scale consists of eight items covering core aspects of positive psychological functioning, including purpose and meaning in life, engagement, supportive social relationships,

competence, self-respect, optimism, and perceived contribution to others' well-being [23]. Items are rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), with higher total scores indicating greater psychological well-being. The Turkish adaptation supported the original unidimensional structure and demonstrated good internal consistency (Cronbach's $\alpha = 0.80$) and strong test–retest reliability ($r = 0.86$) [24].

2.3.2. Self-Compassion Scale–Short Form (SCS-SF)

Self-compassion was assessed using the Turkish short form of the Self-Compassion Scale. The original scale was developed by Neff [25] and later adapted into Turkish [26]. The SCS-SF consists of 12 items representing six dimensions: self-kindness, self-judgment, common humanity, isolation, mindfulness, and over-identification. Items are rated on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). Items reflecting self-judgment, isolation, and over-identification are reverse-scored before calculation of the total score, so that higher values consistently indicate greater self-compassion. The 12 scored items were summed to obtain a total score ranging from 12 to 60, with higher scores indicating greater self-compassion. In the present sample, the SCS-SF demonstrated good internal consistency (Cronbach's $\alpha = 0.897$).

2.3.3. Brief Resilience Scale (BRS)

Resilience was assessed using the Brief Resilience Scale developed by Smith et al. [21] The scale consists of six items measuring the ability to recover or "bounce back" from stress and adversity. Items are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater resilience. The Turkish adaptation demonstrated good internal consistency, with a Cronbach's alpha of 0.83. [27].

2.3.4. Hospital Anxiety and Depression Scale (HADS)

Anxiety and depressive symptoms were assessed using the Hospital Anxiety and Depression Scale developed by Zigmond and Snaith. [28]. The scale consists of 14 items, with seven items assessing anxiety and seven assessing depression. Items are rated on a 4-point Likert scale, yielding separate anxiety and depression subscale scores; higher scores indicate greater symptom severity. The Turkish version demonstrated satisfactory validity and reliability [29].

2.3.5. Oswestry Disability Index (ODI)

Pain-related disability was assessed using the Oswestry Disability Index, originally developed by Fairbank et al. [30] The ODI is a 10-item questionnaire evaluating limitations in daily activities associated with low back pain, including pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, traveling, and sexual activity. Each item is scored from 0 to 5, and the total score is converted to a percentage ranging from 0 to 100, with higher scores indicating greater disability. The Turkish version has demonstrated satisfactory validity and reliability [31].

2.3.6. Visual Analog Scale (VAS)

Pain intensity was assessed using the Visual Analog Scale, a widely used unidimensional measure of subjective pain severity [32]. Participants rated their pain on a scale ranging from 0 (no pain) to 10 (worst imaginable pain), with higher scores indicating greater pain intensity. The VAS is widely used in clinical pain assessment and has demonstrated established reliability, validity, and responsiveness across pain populations.

The Turkish validation of the ODI was conducted specifically in patients with low back pain, whereas the HADS was validated in a medically ill clinical population. The Turkish validation studies of the FS and BRS were conducted in non-clinical student samples.

2.4. Sample Size

Sample-size calculations were performed using G*Power version 3.1, based on an incremental R^2 test in hierarchical multiple regression. The target sample size was informed by previous studies examining psychological predictors of pain-related functioning. Self-compassion has been reported to account for approximately 7% or more of unique variance in functioning among patients with chronic pain [33], corresponding to an approximate Cohen's f^2 of 0.075, whereas smaller effects have been reported for resilience and depressive symptoms in fully adjusted longitudinal models. Assuming a small-to-moderate incremental effect (Cohen's $f^2 = 0.08$–0.10), $\alpha = 0.05$, 80% power, and approximately 11 predictors in the full hierarchical regression model, the required sample size ranged from 81 participants for $f^2 = 0.10$ to 101 participants for $f^2 = 0.08$. The calculation was based on the increase in R^2 associated with the single predictor entered in the final step of the hierarchical regression model. The available retrospective sample comprised 100 patients, which was one participant below the estimate corresponding to $f^2 = 0.08$. The sample-size calculation was therefore used as an approximate planning benchmark rather than as evidence that the target was fully achieved. Sample size estimation was based primarily on the hierarchical regression analyses; the GEE models were considered supportive longitudinal analyses and were not used for the primary power calculation.

2.5. Statistical Analyses

All statistical analyses were performed in Python 3.13.5 (Python Software Foundation, Beaverton, OR, USA) using the pandas 3.1.0 (NumFOCUS, Inc, Austin, TX, USA), SciPy 1.17.0 (NumFOCUS, Inc, Austin, TX, USA), and statsmodels 0.14.6 packages (NumFOCUS, Inc, Austin, TX, USA). Continuous variables were summarized as means and standard deviations, and categorical variables as frequencies and percentages. Distributional characteristics were evaluated using skewness and kurtosis. Changes from baseline to the 1-month follow-up were examined using paired-samples t tests, with Cohen's dz reported as the effect size.

Participants with incomplete required baseline or 1-month outcome data were not included in the analytic sample. No imputation was performed. Sex was coded as 0 = female and 1 = male. Procedure was entered as a categorical variable with S1 as the reference category. VAS and ODI were analyzed on their original clinical scales to preserve interpretability. No outcome transformation was applied.

Associations between baseline psychological measures and changes in clinical outcomes were examined using Pearson correlation coefficients. To account for multiple testing across related correlations, p values were adjusted using the Benjamini–Hochberg false discovery rate procedure.

As an exploratory component analysis, the SCS-SF was additionally separated into positive and negative self-responding components. The positive self-responding score comprised the self-kindness, common humanity, and mindfulness items (items 2, 3, 5, 6, 7, and 10), whereas the negative self-responding score comprised the self-judgment, isolation, and over-identification items (items 1, 4, 8, 9, 11, and 12). For this exploratory analysis, the negative component was oriented so that higher scores represented greater negative self-responding/distress. Mean component scores were calculated and entered simultaneously into baseline-adjusted multivariable models together with the corresponding baseline outcome, age, sex, procedure category, HADS-D, and HADS-A. This analysis was performed

to examine whether the association observed for the total SCS-SF score was predominantly attributable to its negative/distress-related component rather than to infer distinct causal effects of the components.

Baseline-adjusted hierarchical multiple linear regression analyses were conducted for the 1-month outcomes. Baseline outcome severity together with demographic and procedural covariates were entered in the first step, affective symptom measures in the second step, and the psychological predictor of interest in the final step. Incremental model contribution was evaluated using R^2, adjusted R^2, ΔR^2, and change in F. Heteroskedasticity-consistent HC3 standard errors and 95% confidence intervals were used for regression inference. The baseline-adjusted hierarchical regression models of the 1-month outcomes constituted the primary inferential analyses. Change-score correlations were considered unadjusted descriptive/exploratory analyses. Analyses of resilience, well-being, and other psychological variables beyond the primary self-compassion model were considered secondary/exploratory.

Secondary responder analyses were performed to complement the primary continuous-outcome analyses. Clinically meaningful improvement was defined as a ≥30% reduction from baseline in VAS and a ≥10-point reduction in ODI, based on previously proposed thresholds for clinically important change in pain intensity and low-back-pain-related disability [34,35]. Binary logistic regression models were fitted separately for the VAS and ODI responder outcomes. Each model included baseline SCS-SF score, the corresponding baseline outcome, age, sex, depressive symptoms, anxiety symptoms, and procedure category. To reduce sparse parameterization in these secondary models, procedure level was entered using the four-category coding (S1, L5, L5–S1, and other less frequent procedures), with S1 as the reference category.

Because only 38 participants were VAS nonresponders and 32 were ODI nonresponders, the number of outcome events relative to model parameters was limited and conventional maximum-likelihood estimates were considered potentially susceptible to small-sample bias and overfitting. Model convergence and multicollinearity were therefore examined, and bias-reduced Firth logistic regression using the same covariate specification was additionally performed as a sensitivity analysis. These responder analyses were considered secondary and exploratory and were not used to establish individual prognostic performance.

Regression assumptions were evaluated using residual normality, heteroskedasticity, functional-form diagnostics, variance inflation factors and tolerance statistics, studentized residuals, and Cook's distances. Repeated-measures generalized estimating equation (GEE) models were additionally fitted as secondary longitudinal analyses to account for within-participant correlation across the two measurement occasions. Because both VAS and ODI were analyzed as continuous outcomes on their original scales, the GEE models specified a Gaussian family with an identity link and an exchangeable working correlation structure. Robust sandwich standard errors were used for inference. Time was coded as 0 = baseline and 1 = 1-month follow-up. All continuous baseline predictors and age were mean-centered before model estimation to facilitate interpretation of the main effects in models containing time-by-predictor interactions. Sex and procedure type were entered as categorical covariates, with S1 DRG as the reference procedure category.

The baseline-adjusted regression models of the 1-month outcomes constituted the primary inferential analyses. The GEE models were used only as secondary longitudinal representations of the repeated measurements and were not intended as an alternative primary analysis or as an independent validation of the regression findings. With only two measurement occasions, the Time × predictor interaction largely represents the same longitudinal change information examined by the corresponding baseline-to-follow-up association. Separate adjusted GEE models were fitted for each psychological Time × predictor

interaction, and an additional sensitivity model included all psychological predictor-by-time interactions simultaneously. Full model specifications and coefficients are provided in the Supplementary Material.

3. Results

3.1. Participant Characteristics and Clinical Outcomes

The study included 100 participants with a mean age of 48.10 years ($SD = 12.27$), and 51% were male. The most frequently performed procedures were S1 DRG, L5 DRG, and L5–S1 DRG. At baseline, the mean VAS score was 7.94 ($SD = 1.08$), and the mean ODI score was 60.22 ($SD = 16.44$). Baseline VAS scores ranged from 5 to 10 and showed a restricted high-severity distribution, with 69% of participants scoring 8–10; only one participant (1%) had the maximum score of 10. Descriptive statistics for demographic, clinical, and psychological variables are presented in Table 1.

Table 1. Sample characteristics and descriptive statistics.

Continuous Variable	M	SD	Median	Min	Max	Skewness	Kurtosis
Age, years	48.1	12.27	49	18	65	−0.5	−0.38
Baseline VAS (0–10)	7.94	1.08	8	5	10	−0.76	0.08
Resilience (BRS) (6–30)	19.77	4.11	20	9	28	−0.19	−0.27
Well-being (FS) (8–56)	44.69	8.62	47	16	55	−1.09	0.78
Depression (HADS-D) (0–21)	6.62	3.73	6	0	16	0.51	−0.25
Anxiety (HADS-A) (0–21)	7.66	3.93	7	1	19	0.51	0.19
Baseline ODI (0–100)	60.22	16.44	60	24	96	−0.14	−0.52
1-month VAS	4.48	2.24	4	0	9	0.26	−0.97
1-month ODI	38.18	20.6	32	8	90	0.76	−0.4
Self-compassion (SCS-SF)	40.91	8.95	42	23	57	−0.14	−1.15
Categorical variable	**n**	**%**					
Sex:							
female	49	49					
male	51	51					
Procedure:							
S1 DRG	34	34					
L5 DRG	32	32					
L5–S1 DRG	18	18					
L4–5 DRG	8	8					
L3–4 DRG	5	5					
L4 DRG	3	3					

Note. N = 100. Sex was coded 0 = female and 1 = male. Procedure categories were standardized for spelling and spacing; "Other" combines the three rare procedure levels. VAS = visual analog scale; ODI = Oswestry Disability Index; BRS = resilience; FS = well-being; HADS-D = depression; HADS-A = anxiety; SCS-SF = self-compassion.

Both pain intensity and disability improved significantly at the 1-month follow-up (Table 2). Mean VAS decreased from 7.94 ($SD = 1.08$) to 4.48 ($SD = 2.24$), corresponding to a mean change of −3.46 points, $t(99) = -15.00$, $p < 0.001$, Cohen's $dz = -1.50$. Mean ODI decreased from 60.22 ($SD = 16.44$) to 38.18 ($SD = 20.60$), with a mean change of −22.04 points, $t(99) = -13.44$, $p < 0.001$, Cohen's $dz = -1.34$.

Table 2. Baseline-to-1-month changes in pain intensity and disability.

Out-come	Base-line M	Base-line SD	1. Month M	1. Month SD	Mean Change (95%CI)	SD Change	t	df	*p*	Cohen's *dz* (95%CI)
VAS	7.94	1.08	4.48	2.24	−3.46 (−3.92, −3.00)	2.31	−15	99	<0.001	−1.5 (−1.77, −1.29)
ODI	60.22	16.44	38.18	20.6	−22.04 (−25.29, −18.79)	16.4	−13.44	99	<0.001	−1.34 (−1.57, −1.17)

Note. Change was calculated as 1-month minus baseline; therefore, negative values indicate improvement. Paired-samples *t* tests are reported. Cohen's $dz = t/\sqrt{N}$. Both outcomes showed $p < 0.001$.

Clinically Meaningful Improvement

Secondary responder analyses were performed to complement the continuous-outcome analyses. Clinically meaningful pain improvement, defined as a ≥30% reduction in VAS from baseline, was observed in 62 participants (62%), whereas 68 participants (68%) achieved a ≥10-point reduction in ODI. In adjusted logistic regression models, higher baseline self-compassion was associated with greater odds of meeting the VAS responder criterion (OR = 1.28 per one-point increase in SCS-SF, 95% CI [1.15, 1.42], $p < 0.001$) and the ODI responder criterion (OR = 1.40, 95% CI [1.21, 1.62], $p < 0.001$). Because the number of nonresponders was limited relative to the number of model parameters, these estimates were interpreted cautiously. In bias-reduced Firth logistic regression sensitivity analyses using the same covariates, the associations were attenuated but remained statistically significant for both VAS (OR = 1.23, 95% CI [1.12, 1.35]) and ODI (OR = 1.31, 95% CI [1.17, 1.47]) (Supplementary Table S10).

3.2. Associations Between Psychological Variables and Clinical Improvement

A full correlation matrix with 95% confidence intervals is presented in Table S5. In partial correlation analyses controlling for the corresponding baseline outcome, self-compassion remained strongly associated with 1-month VAS (partial r = −0.740, 95% CI [−0.818, −0.636], $p < 0.001$) and 1-month ODI (partial r = −0.771, 95% CI [−0.840, −0.676], $p < 0.001$) (Table S6).

Associations between baseline psychological characteristics and changes in VAS and ODI are shown in Table 3. Because change scores were calculated as 1-month minus baseline values, more negative scores indicated greater improvement. Baseline and 1-month scores were weakly correlated for VAS ($r = 0.179$) and moderately correlated for ODI ($r = 0.628$). Given the restricted baseline distribution of VAS scores and the mathematical properties of change scores, the correlations with change presented in Table 3 were treated as unadjusted exploratory associations rather than as the primary evidence of longitudinal association.

Table 3. Associations of baseline psychological variables with change in VAS and ODI.

Outcome Change	Baseline Predictor	r	*p*	FDR-Adjusted *p*	N
VAS change	BRS	−0.544	<0.001	<0.001	100
VAS change	FS	−0.577	<0.001	<0.001	100
VAS change	HADS-D	0.334	<0.001	<0.001	100
VAS change	HADS-A	0.114	0.259	0.259	100
VAS change	SCS-SF	−0.755	<0.001	<0.001	100
ODI change	BRS	−0.512	<0.001	<0.001	100
ODI change	FS	−0.59	<0.001	<0.001	100
ODI change	HADS-D	0.337	<0.001	<0.001	100
ODI change	HADS-A	0.093	0.357	0.357	100
ODI change	SCS-SF	−0.765	<0.001	<0.001	100

Note. Change = 1-month minus baseline; more negative change indicates greater improvement. Un adjusted Pearson correlations are shown. Benjamini–Hochberg false discovery rate (FDR) correction was applied separately across the five psychological predictors for each outcome.

Self-compassion showed the strongest association with improvement in both VAS ($r = -0.755$) and ODI ($r = -0.765$). Greater resilience and greater well-being were also significantly associated with larger reductions in both outcomes, whereas higher depressive symptom severity was associated with less improvement. These associations remained significant after FDR correction. Anxiety was not significantly associated with change in either VAS or ODI.

3.3. Regression Assumptions and Model Diagnostics

Regression assumptions were examined for the final baseline-adjusted models. Multicollinearity was not considered problematic. In the self-compassion-focused models, the maximum VIF was approximately 1.88 (minimum tolerance ≈ 0.53), whereas in the models including all psychological predictors, VIF values remained below approximately 4.1 (minimum tolerance ≈ 0.24). Thus, no evidence of severe multicollinearity was observed.

For the VAS model, residuals showed no meaningful deviation from normality (Shapiro–Wilk $p = 0.657$), and the Breusch–Pagan test did not indicate heteroskedasticity ($p = 0.279$). The RESET test was also non-significant ($p = 0.206$), supporting an adequate linear functional form. For the ODI model, residual normality was satisfactory (Shapiro–Wilk $p = 0.624$), although the Breusch–Pagan test indicated some heteroskedasticity ($p = 0.027$), and the functional-form assessment suggested some deviation from strict linearity. Therefore, HC3 heteroskedasticity-robust standard errors were used for regression inference.

Influence diagnostics did not indicate that the models were driven by individual observations. The maximum Cook's distances were 0.117 for VAS and 0.159 for ODI, both well below 1. Although some observations exceeded the conservative $4/N$ criterion, no evidence of severe influence was identified. Overall, the regression diagnostics supported the adequacy of the models, with robust inference used to account for the minor assumption deviations observed for ODI.

For the repeated-measures GEE analyses, robust sandwich standard errors were used. Because GEE provides population-averaged estimates and does not require normally distributed residuals or homoscedastic errors in the same manner as ordinary least-squares regression, the OLS residual diagnostics above were not applied to the GEE models.

3.4. Incremental Contribution of Self-Compassion Beyond Depression and Anxiety

Hierarchical regression analyses were conducted to determine whether self-compassion explained additional variance beyond baseline clinical severity, demographic and procedural variables, and symptoms of depression and anxiety (Table 4).

For VAS, baseline VAS, age, sex, and procedure type accounted for 10.5% of the variance in 1-month VAS. Adding depression and anxiety increased the explained variance by 17.0%, $\Delta R^2 = 0.170$, robust $\Delta F(2, 89) = 6.30$, $p = 0.003$. The addition of self-compassion in the final step explained a further 34.8% of the variance, $\Delta R^2 = 0.348$, robust $\Delta F(1, 88) = 74.49$, $p < 0.001$. In the final model, self-compassion remained strongly associated with lower 1-month VAS, $B = -0.185$, $\beta = -0.739$, 95% CI $[-0.228, -0.142]$, $p < 0.001$.

Table 4. Hierarchical regression models testing the incremental contribution of self-compassion beyond depressive and anxiety symptoms.

Panel A. 1-Month VAS						
Hierarchical Step	**R^2**	**Adjusted R^2**	**ΔR^2**	**HC3 ΔF**	**df**	***p* for ΔF**
Step 1: Baseline outcome + age + sex + procedure	0.105	0.026	—	—	—	—
Step 2: + Depression + anxiety	0.275	0.193	0.17	6.295	2, 89	0.003
Step 3: + Self-compassion	0.623	0.576	0.348	74.486	1, 88	<0.001
Final model predictor	**B**	**HC3 SE**	**β**	***t***	**95% CI**	***p***
Intercept	7.778	1.567	—	4.965	[4.665, 10.892]	<0.001
Baseline VAS	0.631	0.184	0.305	3.436	[0.266, 0.997]	<0.001
Depression	0.113	0.068	0.188	1.672	[−0.021, 0.248]	0.098
Anxiety	−0.137	0.06	−0.240	−2.284	[−0.256, −0.018]	0.025
Self-compassion	−0.185	0.021	−0.739	−8.631	[−0.228, −0.142]	<0.001
Age	−0.006	0.018	−0.030	−0.308	[−0.041, 0.030]	0.759
Sex (male vs. female)	−0.351	0.357	−0.079	−0.983	[−1.059, 0.358]	0.328
L3–4 DRG	−0.061	1.077	−0.006	−0.057	[−2.201, 2.079]	0.955
L4–5 DRG	0.831	0.978	0.101	0.849	[−1.114, 2.775]	0.398
L5 DRG	−0.102	0.376	−0.021	−0.272	[−0.850, 0.645]	0.786
L5–S1 DRG	−0.263	0.492	−0.045	−0.535	[−1.240, 0.714]	0.594
L4 DRG	0.529	0.586	0.04	0.903	[−0.636, 1.694]	0.369
Panel B. 1-month ODI						
Hierarchical step	**R^2**	**Adjusted R^2**	**ΔR^2**	**HC3 ΔF**	**df**	***p for ΔF***
Step 1: Baseline outcome + age + sex + procedure	0.446	0.397	—	—	—	—
Step 2: + Depression + anxiety	0.515	0.461	0.07	3.563	2, 89	0.032
Step 3: + Self-compassion	0.792	0.766	0.277	93.331	1, 88	< 0.001
Final model predictor	**B**	**HC3 SE**	**β**	***t***	**95% CI**	***p***
Intercept	48.877	9.785	—	4.995	[29.431, 68.323]	<0.001
Baseline ODI	0.855	0.082	0.683	10.407	[0.692, 1.018]	<0.001
Depression	0.553	0.483	0.1	1.144	[−0.407, 1.514]	0.256
Anxiety	−1.046	0.431	−0.200	−2.428	[−1.903, −0.190]	0.017
Self-compassion	−1.417	0.147	−0.616	−9.661	[−1.709, −1.126]	<0.001
Age	0.012	0.14	0.007	0.086	[−0.266, 0.290]	0.932

Table 4. *Cont.*

Sex (male vs. female)	−0.995	2.504	−0.024	−0.397	[−5.971, 3.981]	0.692
L3–4 DRG	−0.823	8.474	−0.009	−0.097	[−17.663, 16.017]	0.923
L4–5 DRG	3.657	6.396	0.048	0.572	[−9.055, 16.369]	0.569
L5 DRG	0.885	2.461	0.02	0.36	[−4.005, 5.775]	0.72
L5–S1 DRG	−3.428	3.771	−0.064	−0.909	[−10.922, 4.067]	0.366
L4 DRG	5.445	4.886	0.045	1.114	[−4.265, 15.155]	0.268

Note. N = 100. S1 DRG was the reference procedure category. Hierarchical blocks were entered in the stated order. R^2 and ΔR^2 describe explained variance. HC3 heteroskedasticity-robust standard errors were used for coefficient inference, and HC3 robust joint F tests are reported for the variables added at each block. Step 3 tests whether self-compassion explains additional variance beyond baseline outcome severity, age, sex, procedure, depression, and anxiety.

For ODI, the first step explained 44.6% of the variance in 1-month ODI. Depression and anxiety added 7.0% of explained variance, $\Delta R^2 = 0.070$, robust $\Delta F(2, 89) = 3.56$, $p = 0.032$. Self-compassion subsequently explained an additional 27.7% of the variance, $\Delta R^2 = 0.277$, robust $\Delta F(1, 88) = 93.33$, $p < 0.001$. In the final model, self-compassion was independently associated with lower ODI, $B = -1.417$, $\beta = -0.616$, 95% CI [−1.709, −1.126], $p < 0.001$.

Parallel supplementary analyses were conducted for well-being and resilience using the same hierarchical structure. Well-being explained an additional 16.9% of the variance in VAS and 12.9% in ODI after adjustment for the preceding blocks, whereas resilience explained an additional 11.8% and 7.5%, respectively. Both predictors were independently associated with better 1-month outcomes in their respective final models. Full results for these analyses are presented in Supplementary Table S1 for resilience and Supplementary Table S2 for well-being.

Sensitivity Analysis

In addition, in the joint models including self-compassion, resilience, and well-being simultaneously, self-compassion remained independently associated with both 1-month VAS (B = −0.165, 95% CI [−0.229, −0.100], $p < 0.001$) and 1-month ODI (B = −1.371, 95% CI [−1.817, −0.924], $p < 0.001$), whereas resilience and well-being were not independently associated with either outcome. For the joint psychological-resource models, robust regression sensitivity analyses yielded comparable estimates for self-compassion (VAS: B = −0.157, 95% CI [−0.211, −0.104]; ODI: B = −1.351, 95% CI [−1.693, −1.008]; both $p < 0.001$).

Influence sensitivity analyses using the conservative Cook's D > 4/N criterion yielded similar self-compassion estimates after exclusion of influential observations (VAS: B = −0.176, 95% CI [−0.210, −0.142]; ODI: B = −1.359, 95% CI [−1.610, −1.108]; both $p < 0.001$). Corresponding Huber robust regression estimates were also similar (VAS: B = −0.177, 95% CI [−0.218, −0.136]; ODI: B = −1.407, 95% CI [−1.654, −1.160]; both $p < 0.001$; Supplementary Table S9).

Additional sensitivity analyses were performed because the ODI model showed evidence of functional-form deviation. In the quadratic model, the self-compassion squared term was not significant ($p = 0.329$), whereas the quadratic term for baseline ODI was significant ($p = 0.044$). Importantly, self-compassion remained strongly associated with 1-month ODI (B = −1.368, 95% CI [−1.674, −1.061], $p < 0.001$). Similarly, when baseline ODI was modeled flexibly using cubic spline terms, the self-compassion estimate remained essentially unchanged (B = −1.359, 95% CI [−1.693, −1.026], $p < 0.001$; Supplementary Table S7).

As another sensitivity analysis, the procedure variable was collapsed into four clinically interpretable categories (S1, L5, L5–S1, and other less frequent procedures), and the

primary multivariable models were re-estimated using this coding. The self-compassion estimates remained essentially unchanged for both 1-month VAS (B = −0.184, 95% CI [−0.224, −0.143], $p < 0.001$) and 1-month ODI (B = −1.419, 95% CI [−1.699, −1.140], $p < 0.001$), indicating that the findings were not sensitive to the original sparse procedure categorization (Supplementary Table S8).

In an independent exploratory baseline-adjusted multivariable analysis including age, sex, procedure category, depressive symptoms, anxiety symptoms, and the corresponding baseline outcome, both positive and negative self-responding remained independently associated with 1-month outcomes when entered simultaneously. For VAS, positive self-responding was associated with lower 1-month pain (B = −0.876, β = −0.307, 95% CI [−1.575, −0.177], $p = 0.014$), whereas greater negative self-responding was associated with higher 1-month pain (B = 1.330, β = 0.458, 95% CI [0.474, 2.187], $p = 0.002$). Similar associations were observed for ODI (positive self-responding: B = −6.147, β = −0.234, 95% CI [−10.517, −1.776], $p = 0.006$; negative self-responding: B = 10.981, β = 0.412, 95% CI [5.539, 16.424], $p < 0.001$). Thus, the association was not exclusively attributable to the negative component, although its standardized association was somewhat larger.

3.5. Repeated-Measures GEE Analyses

Adjusted repeated-measures GEE models were used to examine whether baseline self-compassion was associated with differential changes in pain intensity and disability over time, while controlling for resilience, well-being, depression, anxiety, age, sex, and procedure type (Table 5).

For VAS, there was a significant overall reduction from baseline to 1 month, $B = -3.460$, robust SE = 0.150, $z = -22.99$, $p < 0.001$. More importantly, the Time × self-compassion interaction was significant, $B = -0.195$, robust SE = 0.014, 95% CI [−0.223, −0.166], $p < 0.001$, indicating greater reductions in pain among participants with higher baseline self-compassion. Depression and sex also showed significant main effects in the adjusted model.

A similar pattern was observed for ODI. Disability decreased significantly over time, $B = -22.040$, robust SE = 1.051, $z = -20.97$, $p < 0.001$. The Time × self-compassion interaction was again significant, $B = -1.401$, robust SE = 0.100, 95% CI [−1.598, −1.205], $p < 0.001$, indicating greater improvement in disability among participants with higher baseline self-compassion. Depression and sex were also significantly associated with ODI in the adjusted model (Table 5).

In separate adjusted GEE models, significant Time × resilience, Time × well-being, and Time × depression interactions were also observed for both VAS and ODI, whereas Time × anxiety was not significant. (Table S3). In a sensitivity GEE model including all psychological predictor-by-time interactions simultaneously, the Time × self-compassion interaction remained significant for both VAS (B = −0.187, robust SE = 0.025, $p < 0.001$) and ODI (B = −1.401, robust SE = 0.176, $p < 0.001$). Thus, the longitudinal association with self-compassion remained evident after simultaneous inclusion of the corresponding time interactions for resilience, well-being, depression, and anxiety. These GEE analyses were considered secondary longitudinal representations of the repeated measurements rather than independent validation of the primary baseline-adjusted regression models (Supplementary Table S4).

Table 5. Adjusted repeated-measures GEE models testing whether baseline self-compassion is associated with changes in VAS and ODI.

Panel A. VAS					
Predictor	**B**	**Robust SE**	***z***	**95% CI**	***p***
Intercept	8.404	0.237	35.405	[7.939, 8.869]	<0.001
Time (baseline → 1 month)	−3.460	0.150	−22.992	[−3.755, −3.165]	<0.001
Self-compassion	0.050	0.020	2.566	[0.012, 0.089]	0.010
Resilience	0.002	0.038	0.054	[−0.072, 0.076]	0.957
Well-being	−0.014	0.025	−0.562	[−0.062, 0.035]	0.574
Depression	0.120	0.048	2.534	[0.027, 0.214]	0.011
Anxiety	−0.036	0.033	−1.117	[−0.100, 0.027]	0.264
Age	0.004	0.011	0.351	[−0.018, 0.026]	0.726
Sex (male vs. female)	−0.688	0.234	−2.935	[−1.148, −0.229]	0.003
L3–4 DRG	−0.108	0.505	−0.214	[−1.098, 0.882]	0.830
L4–5 DRG	0.380	0.616	0.617	[−0.827, 1.588]	0.537
L5 DRG	−0.358	0.262	−1.364	[−0.872, 0.156]	0.173
L5–S1 DRG	−0.113	0.304	−0.370	[−0.709, 0.484]	0.712
L4 DRG	−0.113	0.500	−0.226	[−1.094, 0.867]	0.821
Time × self-compassion	−0.195	0.014	−13.551	[−0.223, −0.166]	<0.001
Panel B. ODI					
Predictor	**B**	**Robust SE**	***z***	**95% CI**	***p***
Intercept	66.856	3.335	20.047	[60.320, 73.393]	<0.001
Time (baseline → 1 month)	−22.040	1.051	−20.974	[−24.100, −19.980]	<0.001
Self-compassion	0.099	0.271	0.366	[−0.432, 0.630]	0.714
Resilience	0.468	0.605	0.773	[−0.718, 1.653]	0.439
Well-being	0.151	0.276	0.546	[−0.391, 0.692]	0.585
Depression	1.243	0.567	2.193	[0.132, 2.353]	0.028
Anxiety	0.015	0.434	0.035	[−0.834, 0.865]	0.972
Age	−0.044	0.140	−0.314	[−0.319, 0.231]	0.753
Sex (male vs. female)	−10.464	3.278	−3.192	[−16.889, −4.040]	0.001
L3–4 DRG	−7.105	9.392	−0.757	[−25.513, 11.302]	0.449
L4–5 DRG	−1.423	5.501	−0.259	[−12.205, 9.359]	0.796
L5 DRG	−3.689	3.755	−0.982	[−11.049, 3.672]	0.326
L5–S1 DRG	0.896	4.296	0.209	[−7.524, 9.316]	0.835
L4 DRG	6.296	9.064	0.695	[−11.469, 24.062]	0.487
Time × self-compassion	−1.401	0.100	−13.989	[−1.598, −1.205]	<0.001

Note. GEE = generalized estimating equation. Robust sandwich standard errors are reported. Time was coded as 0 = baseline and 1 = 1-month follow-up. All continuous baseline predictors and age were mean-centered before analysis; sex and procedure type were entered as categorical variables. S1 DRG was the reference procedure category. The Time × self-compassion term tests whether change in the outcome over time differs according to baseline self-compassion.

4. Discussion

The principal finding of this study was that higher preprocedural self-compassion was strongly associated with more favorable 1-month pain and disability outcomes among patients undergoing DRG-targeted interventional treatment for lumbar radicular pain. These associations remained evident after adjustment for the corresponding baseline outcome, age, sex, procedure type, depressive symptoms, and anxiety symptoms. Self-compassion also accounted for substantial additional variance in both outcomes. However, the magnitude of these associations was relatively large and should be interpreted cautiously. The estimates may partly reflect characteristics of this clinically selected sample, residual confounding, or shared-method variance because both psychological factors and clinical outcomes were assessed using self-report measures. Accordingly, these findings should

be considered explanatory and hypothesis-generating rather than evidence of established prognostic performance.

These findings are consistent with previous studies suggesting that response to interventional treatments may not be explained solely by anatomical characteristics. Although interventions targeting the nerve root are intended to reduce local inflammation and radicular pain, clinical response can vary substantially among patients [8,9]. A recent systematic review examining factors potentially associated with treatment response following lumbar transforaminal epidural steroid injections identified several prognostic factors related to imaging, clinical, and electrophysiological characteristics; however, the findings were inconsistent across studies, and the available evidence was reported to carry varying levels of risk of bias [36]. Our findings extend this framework by suggesting that adaptive psychological characteristics present before treatment may also be associated with clinical change following the intervention.

Studies conducted in different chronic pain populations have shown that higher levels of self-compassion may be associated with less catastrophizing and psychological distress, more adaptive approaches to coping with pain, and less pain-related functional disability [18,19,37]. More recently, Gillett et al. reported that higher self-compassion among individuals with chronic pain was associated with lower pain intensity and less interference of pain with daily life, as well as lower levels of anxiety, depression, and pain catastrophizing [38]. Our finding that baseline self-compassion was associated with pain and functional outcomes at 1 month is consistent with previous research, while demonstrating this association specifically among patients undergoing DRG-targeted interventional treatment provides an additional clinical perspective to the existing literature.

Previous intervention studies provide related but not directly comparable evidence. For example, Zheng et al. [39] reported that adding self-compassion training to core stabilization exercises improved outcomes in patients with nonspecific chronic low back pain. However, that population, intervention, and study design differ substantially from those of the present study, which involved patients undergoing DRG-targeted interventional treatment and examined naturally occurring preprocedural self-compassion rather than an intervention designed to modify it. Therefore, evidence from self-compassion training studies cannot be extrapolated to infer that increasing self-compassion would improve response to DRG-targeted treatment. The present findings indicate an association between preprocedural self-compassion and subsequent short-term outcomes, but do not establish either a causal mechanism or a modifiable treatment target.

In addition to self-compassion, higher levels of resilience and psychological well-being were also associated with greater improvements in pain and functional disability in separate analyses. This is consistent with literature suggesting that adaptation to chronic pain cannot be understood solely in terms of psychological risk factors and that positive psychological resources related to resilience and well-being may also contribute to functioning [40]. Similarly, Edwards et al. reported that higher self-compassion was associated with lower depression, pain anxiety, and disability, as well as greater pain acceptance and better functioning [33]. In the present study, however, resilience and psychological well-being were no longer independently associated with outcomes when considered jointly with self-compassion, whereas higher baseline depressive symptom severity was associated with less clinical improvement. The association of anxiety differed between the unadjusted and fully adjusted analyses, with a negative coefficient emerging only after multivariable adjustment. The anxiety findings should be interpreted cautiously. HADS-A was not significantly associated with change in VAS or ODI in the unadjusted analyses, but its coefficient became negative and statistically significant in the fully adjusted models. This reversal is consistent with a statistical suppression or conditional association arising from adjustment for corre-

lated psychological variables, particularly depression and self-compassion. Accordingly, the negative adjusted coefficient should not be interpreted as evidence that greater anxiety is clinically beneficial or predicts better treatment response.

Taken together, these findings suggest that adaptive psychological characteristics may contribute to a broader biopsychosocial understanding of short-term outcomes in interventional pain settings. However, the present results do not establish the clinical utility of psychological screening for treatment selection or individual prognostic prediction.

From a clinical perspective, these findings suggest that self-compassion may be considered as one element of a broader biopsychosocial assessment of patients undergoing interventional treatment for chronic lumbar pain. Identifying patients with lower self-compassion or greater negative self-responding may help clinicians recognize individuals with a greater psychological burden who could benefit from more comprehensive psychosocial assessment or supportive interventions alongside standard pain management. However, the present study does not support using self-compassion scores to determine eligibility for DRG-targeted procedures, to select one intervention over another, or to predict an individual patient's treatment response. Nor do these observational findings establish that interventions aimed at increasing self-compassion would causally improve pain or disability outcomes.

The strengths of this study include the assessment of psychological variables before the intervention, reassessment of clinical outcomes at follow-up, and examination of the association between self-compassion and clinical outcomes using multivariable models adjusted for baseline clinical severity, demographic and procedural characteristics, and symptoms of depression and anxiety. In addition, the supportive GEE analyses provided a complementary longitudinal representation of the same underlying association by explicitly modeling within-participant change over time. Because both approaches were based on the same participants and the same two measurement occasions, the GEE findings should not be interpreted as independent validation of the regression results.

Nevertheless, the findings should be interpreted in light of several limitations. The relatively large incremental R^2 values for self-compassion should be interpreted cautiously. Given the modest sample size ($N = 100$) and model complexity, these effect estimates may be sample-specific and potentially inflated by overfitting. In addition, because both self-compassion and the clinical outcomes were assessed using self-report measures, shared-method variance may have contributed to the strength of the observed associations. Residual confounding from unmeasured clinical factors may also have influenced these estimates.

The observational design does not permit causal inference; therefore, the association between self-compassion and more favorable clinical outcomes should not be interpreted as evidence that self-compassion directly enhances treatment response. Similarly, the persistence of the positive and negative self-responding components in adjusted models should not be interpreted as evidence of component-specific causal effects or as demonstrating that self-compassion specifically modifies the response to DRG-targeted treatment. The follow-up period was limited to 1 month, and therefore the present findings reflect only short-term outcomes. In a chronic pain population, this duration is insufficient to determine whether the observed improvements or psychological associations are sustained over the longer term.

The substantial pre–post improvement should also be interpreted cautiously. High baseline symptom severity and the restricted upper-range distribution of VAS scores may have increased the influence of regression to the mean. Natural fluctuations, spontaneous improvement, placebo and expectation effects, and other contextual factors may also have contributed to the observed changes; without an untreated or comparator group, these influences cannot be distinguished from procedure-specific benefit.

Although all patients underwent the same interventional treatment protocol, heterogeneity existed in the underlying lumbar pathologies and targeted nerve root levels. Although the targeted nerve root level was included as a covariate in the statistical models, the potential influence of underlying diagnostic differences on clinical outcomes cannot be entirely excluded. In addition, because both the psychological variables and the primary clinical outcomes were assessed using self-report measures, shared-method variance and reporting bias may have contributed to the observed associations.

Model diagnostics also identified some uncertainty, particularly influential observations and evidence of functional-form deviation in the ODI model. Although influence analyses, robust regression, alternative procedure coding, and nonlinear sensitivity analyses yielded broadly similar self-compassion estimates, these analyses do not constitute independent validation and uncertainty remains regarding the precise magnitude and generalizability of the observed associations.

Because detailed baseline data for records excluded owing to incomplete baseline or follow-up assessments were not retained in the analytic dataset, a formal comparison between included and excluded patients could not be performed. Selection bias related to the complete-record analytic design therefore cannot be excluded. Finally, data on several potentially relevant clinical factors were unavailable in the retrospective dataset, including concomitant use of analgesic or neuromodulatory medications and ongoing physical therapy or other conservative treatments. These factors may have influenced short-term pain and functional outcomes; therefore, residual confounding cannot be entirely excluded. The single-centre setting further limits generalizability. Future prospective multicentre studies with larger independent cohorts and follow-up assessments at 3, 6, and 12 months are needed to examine whether these associations persist and to assess their generalizability.

5. Conclusions

In conclusion, higher preprocedural self-compassion was independently associated with more favorable short-term pain and functional outcomes following DRG-targeted interventional treatment. This association remained evident after adjustment for baseline severity, demographic and procedural factors, depressive and anxiety symptoms, and related psychological resources. These findings suggest that self-compassion may be relevant as part of a broader biopsychosocial assessment of patients receiving interventional pain treatment. However, the present results do not establish prognostic performance, support treatment selection or exclusion based on self-compassion scores, or demonstrate that increasing self-compassion would causally improve treatment outcomes. Larger prospective studies with independent validation and longer follow-up are needed before any individualized clinical decision-making based on self-compassion can be recommended.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/healthcare14224002/s1, Figure S1: Associations of baseline self-compassion with baseline, 1-month, and change scores; Table S1: Hierarchical regression testing the incremental contribution of resilience; Table S2: Hierarchical regression testing the incremental contribution of well-being; Table S3: Full coefficients from separate adjusted GEE models containing one Time × psychological predictor interaction at a time; Table S4: Sensitivity GEE models including all Time × psychological predictor interactions simultaneously; Table S5: Pearson correlations among continuous predictors and clinical outcomes; Table S6: Partial correlations with 1-month outcomes controlling for corresponding baseline values; Table S7: Sensitivity analyses addressing functional-form deviation in the ODI model; Table S8: Sensitivity analyses using the collapsed four-category procedure variable; Table S9: Influence and robust-regression sensitivity analyses for the primary self-compassion models; Table S10. Adjusted logistic regression models for clinically meaningful improvement Table S11: Completed STROBE checklist for observational studies.

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Informed Consent Statement: Written informed consent was obtained for the interventional procedure as part of routine clinical care. The present study involved the retrospective secondary analysis of existing clinical records following approval by the institutional Ethics Committee. No study-specific informed consent was obtained because the data had been collected previously as part of routine clinical care.

Data Availability Statement: The data supporting the findings of this study are not publicly available due to privacy and ethical restrictions, as they contain sensitive information that could compromise the confidentiality of the participants. Data may be made available from the corresponding author, İbrahim Hakkı Karakus [mdibrahimhakkikarakus@gmail.com], upon reasonable request and subject to applicable ethical and institutional approvals.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

DRG	Dorsal Root Ganglion
VAS	Visual Analog Scale
ODI	Oswestry Disability Index
FS	Flourishing Scale
SCS-SF	Self-Compassion Scale–Short Form
BRS	Brief Resilience Scale
HADS	Hospital Anxiety and Depression Scale
GEE	Generalized Estimating Equation

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