

Improvements in Mental Well-Being and its Predictive Factors in Patients who Underwent Cervical versus Lumbar Decompression Surgery

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Abstract:

Introduction: Mental well-being is essential for patient satisfaction. Therefore, a better understanding of the changes in the mental well-being of patients following spinal surgery can be useful to surgeons. We compared the 2-year postoperative change in the mental well-being of patients who underwent cervical and lumbar decompression surgery. Additionally, the predictive factors for improvement in mental well-being associated with both methods were evaluated.

Methods: The patients who underwent spinal decompression surgery and were followed >2 years postoperatively were enrolled (lumbar cohort: n=111, cervical cohort: n=121). The 36-item Short-Form Health Survey (SF-36) mental component summary (MCS) was set as the mental well-being parameter, and the minimal clinically important difference (MCID) was defined as 4.0. After adjusting the cervical and lumbar cohorts using propensity scores, the improvements in the MCS were compared between the groups using a mixed-effect model. To identify predictors for improvements, the correlation between the MCS changes and preoperative clinical scores was evaluated. Subsequently, multivariate linear regression was applied, which included variables with $p < 0.10$ in the former analysis as explanatory variables, and the change of MCS as the objective variable.

Results: There were no significant differences in the MCS improvement between the adjusted cervical and lumbar cohorts; 47% and 49%, respectively, had MCS improvement score >MCIDs. However, predictors for the improvement were different between the two cohorts: SF-36 Social functioning in cervical surgery and lower back pain and SF-36 Role physical in lumbar surgery.

Conclusions: Although there was no significant difference in the improvement in the mental well-being between patients who underwent either cervical or lumbar decompression surgery, less than half of the patients in both groups achieved a meaningful improvement. Preoperative back pain and personal activity were independent predictors in the lumbar cohort, while social functioning was the only predictor in the cervical cohort.

Level of evidence: III

Keywords:

mental well-being, quality of life, cervical, lumbar, predictor

Spine Surg Relat Res 2022; 6(1): 10-16
dx.doi.org/10.22603/ssrr.2021-0060

Introduction

In the past several decades, patient satisfaction ratings have played an increasing role in managing reimbursement as part of the ongoing pay-for-performance initiative, which has resulted in the medical community placing a greater emphasis on patient satisfaction¹. Among many factors, mental well-being has been reported as one of the most important

factors for patient satisfaction². Hence, understanding the changes in mental well-being after spinal surgery could be critical for spinal surgeons.

A statistical comparison between two groups can provide beneficial information for the identification and understanding of the characteristics of the two groups³. Although some types of comparisons between patients with either cervical or lumbar spinal stenosis can be unfair (because the cause

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Received: March 24, 2021, Accepted: May 6, 2021, Advance Publication: June 11, 2021

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and symptoms are different), mental well-being was a common factor regardless of cervical or lumbar disease. In addition, those two diseases are the top two major diseases in our fields. Hence, a comparison of the improvement of mental well-being between patients who underwent either cervical or lumbar surgery can be helpful to identify characteristics of each disease with respect to the mental quality of life (QOL).

Many factors could impact the improvement of mental well-being after surgery, such as age, gender, the severity of comorbidity, and preoperative status of mental well-being^{2,4,5}. Because of inherent limitations in observational datasets, propensity score matching, which is a statistical procedure enabling the selection of matched control groups using logistic regression analysis, was established to reduce the effects of potential confounding factors^{6,7}.

Therefore, this study aimed to compare the 2-year postoperative changes in mental well-being between cervical and lumbar decompression surgeries after adjustments for basic demographics, including age, gender, the severity of comorbidity, and preoperative status of mental well-being by propensity scores. We also determined the predictive factors for the improvement of the mental well-being of patients in both groups.

Materials and Methods

This was a retrospective cohort study. All study participants provided informed consent, and the study protocol was approved by the Institutional Review Board of our institution.

Cervical cohort

A total of 121 patients were included in the cervical cohort (71 females, 50 males; mean age at surgery, 65.8±11.7 years). The inclusion criteria were as follows: patients who underwent C3-C6 laminoplasty for cervical spondylotic myelopathy between 2008 and 2013 and were followed up for more than 2 years postoperatively. Patients were excluded if any of their preoperative or 2-year follow-up data were missing, if they were diagnosed with depression or schizophrenia prior, or if they had routinely taken medications for such mental disorders.

Cervical decompression surgery

All patients underwent open-door laminoplasty from C3 to C6⁸. The surgical indication and approach were decided upon on a case-by-case basis by the treating physicians. The day after the surgery, all patients were allowed to sit up with a soft neck collar and to stand and walk. Removal of the soft brace was allowed 1 week after surgery. All patients were then encouraged to start range of motion and isometric muscle strengthening exercises of the neck as early as possible.

Lumbar cohort

A total of 111 patients were included in the lumbar cohort (34 females, 67 males; mean age at surgery, 67.3±10.8 years). The inclusion criteria were as follows: patients who underwent single or multilevel microendoscopic posterior decompression for lumbar spinal stenosis at our institution between 2008 and 2013 and were followed up for more than 2 years postoperatively. Patients were excluded if any of their preoperative or 2-year follow-up data were missing, or if they were diagnosed with depression or schizophrenia prior, or if they had routinely taken medications for such mental disorders.

Lumbar decompression surgery

The patients who had neurogenic claudication or radicular pain with associated neurological signs, had severe stenosis on magnetic resonance imaging, did not have accompanied anterior slippage greater than 25% and segmental kyphosis in flexion greater than 5°, and did not show improvement despite adequate conservative treatment for at least three months were treated with minimum invasive posterior decompression with a microendoscope. Decompression surgery was performed under general anesthesia and as previously reported⁹. The day after surgery, all patients were encouraged to stand and walk.

Preoperative data

From the medical records, data regarding the patients' age at surgery, gender, height, weight, body mass index (BMI), and The American Society of Anesthesiologists Physical Status Classification System (ASA-PS), which indicates the severity of comorbidities, were collected¹⁰.

Clinical evaluation

The cervical Japanese Orthopaedic Association (c-JOA) and lumbar JOA scores were evaluated in patients in the cervical and lumbar cohorts, respectively, preoperatively and 2 years postoperatively^{11,12}. Furthermore, the patient-oriented questionnaire scores, the visual analog scale (VAS) for neck and arm pain in the cervical cohort, VAS for lower back and leg pain in the lumbar cohort, and the 36-item Short-Form Health Survey (SF-36) were recorded preoperatively and 2 years postoperatively. The SF-36 is a 36-item scale that measures eight domains of health status: physical functioning, physical role limitations (RP), bodily pain (BP), general health perceptions (GH), energy/vitality (VT), social functioning (SF), emotional role limitations (RE), and mental health (MH). Each domain's score was summarized into the physical component summary and mental component summary (MCS), according to an algorithm proposed by a previous report¹³.

Mental well-being parameter

In this study, we adopted the MCS score of the SF-36 as the parameter of mental well-being¹⁴. Based on previous evi-

dence, the minimal clinically important difference (MCID) of the MCS was defined as 4.0 in each cohort^{15,16}.

Study design & statistical analysis

First, the age, gender ratio, average MCS score, and the average ASA-PS were compared between the cervical and lumbar cohorts using the chi-squared test for categorical variables and the Mann-Whitney U test for continuous variables.

Secondly, to determine the characteristics of the improvement of MCS after cervical and lumbar surgery, adjusted cervical and lumbar cohorts were created using propensity score matching. To estimate the propensity score, we fitted a logistic regression model using the patient's age, gender, ASA-PS, and preoperative MCS score. The nearest-neighbor matching procedure was used, with the restriction that the matched propensities had to be within 0.01 units of each other. To evaluate the characteristics of the backgrounds of the two adjusted cohorts, the age, gender, ASA-PS, height, weight, BMI, and each subdomain and the MCS of the preoperative SF-36 were compared between the adjusted cervical and lumbar cohorts using Mann-Whitney U test or chi-squared test. Subsequently, the improvement of MCS was compared between the adjusted cervical and lumbar cohorts using a mixed-effect model, and the number of patients who achieved an improvement greater than the MCID was compared between two adjusted cohorts using the chi-squared test.

Finally, to identify the preoperative clinical scores that could predict the MCS improvement after surgery, the Pearson product-moment correlation coefficients between the change of MCS and preoperative clinical scores were calculated in each cohort as a univariate analysis. Subsequently, a multivariate linear regression model was applied. Variables with a significance of $p < 0.10$ in the univariate analysis and basic data, including age and gender, were included as explanatory variables, and the change of MCS score was set as the objective variable. The correlations between each variable included in the multivariate analysis were evaluated before running the analysis using Pearson's correlation coefficient or Spearman's rank correlation coefficient. The combination for which correlation coefficient was >0.70 or <-0.70 were eliminated from the multivariate analysis. Standardized partial regression coefficients (β) and p-values were calculated. All analyses were performed using SPSS software (version 23; SPSS, Chicago, IL, USA). A value of $p < 0.05$ was considered statistically significant.

Results

Although there was no significant difference in the average age ($p=0.334$), there was a significant difference in the ratio of females to males between the non-adjusted cervical and lumbar cohorts ($p < 0.001$). The distribution of ASA-PS showed no significant difference between the non-adjusted cervical and lumbar cohorts ($p=0.059$); 11 patients were

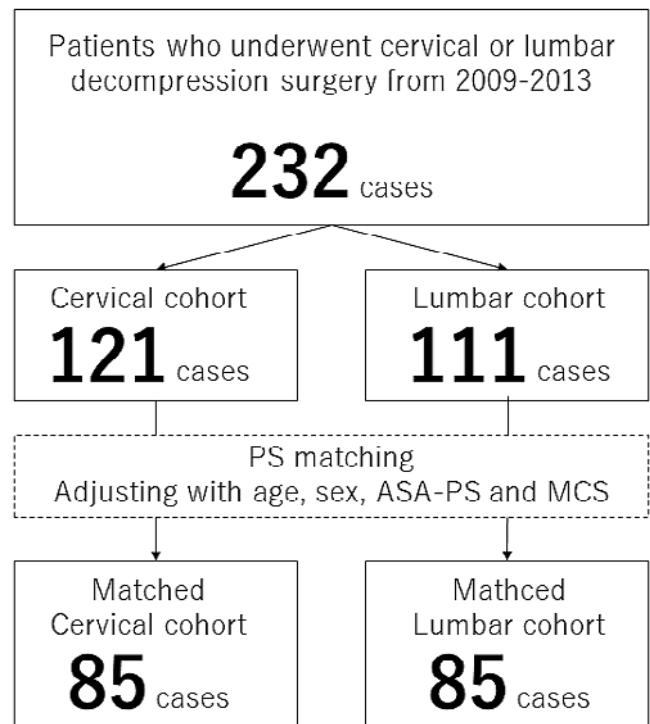


Figure 1. Summary of the grouping.

Grade 1, 100 patients were Grade 2, and 11 patients were Grade 3 in the cervical cohort; meanwhile, 21 patients were Grade 1, 81 patients were Grade 2, and 9 patients were Grade 3 in the lumbar cohort. Additionally, there was no significant difference in the average preoperative MCS score between groups (41.8 ± 13.7 in the cervical cohort and 43.9 ± 13.4 in the lumbar cohort, $p=0.234$).

Comparison of MCS improvement

As the result of the matching with propensity scores calculated with age, gender, ASA-PS, and preoperative MCS score, a total of 170 patients were enrolled into either the adjusted cervical cohort group ($n=85$) or adjusted lumbar cohort ($n=85$) for the following analysis (Fig. 1). There were no significant differences between the two adjusted cohorts in age ($p=0.697$), gender ($p=1.000$), average grades of ASA-PS ($p=0.731$), and preoperative MCS score ($p=0.856$, Table 1). In addition, there were no significant differences in the average height, weight, BMI, and each subdomain of the preoperative SF-36 between the adjusted cervical and lumbar cohorts (Table 1). In the comparison of average MCS improvement after surgery between the adjusted cervical and lumbar cohorts, although both groups showed a significant improvement 2 years postoperatively compared with the preoperative score ($p < 0.05$, respectively), there were no significant differences between the two adjusted groups ($p=0.986$, Fig. 2). In terms of individual cases, no significant difference was observed in the number of patients who achieved a greater improvement in MCS than in MCID; 40 patients (47.1%) in the adjusted cervical cohort and 42 patients (49.4%) in the adjusted lumbar cohort showed an improvement in MCS greater than the MCID ($p=0.878$, Table 2).

The preoperative clinical score related to the improvement of MCS

In the cervical cohort, univariate analysis demonstrated that there were significant correlations between MCS improvement and preoperative SF-36 RP (p=0.004), SF-36 VT

Table 1. Comparison Between Adjusted Cervical and Adjusted Lumbar Cohort.

	Adjusted cervical cohort	Adjusted lumbar cohort	p-value
Total number	85	85	
Age (years)	71 [60, 75]	68 [60, 74]	0.697*
Gender			1.000#
Female	35	34	
Male	50	51	
Height (cm)	158.0 [152.0, 165.8]	160.3 [154.2, 167.3]	0.227*
Weight (kg)	60.5 [52.8, 69.5]	58.8 [53.2, 71.2]	0.409*
BMI	23.9 [21.8, 26.5]	24.0 [21.9, 26.0]	0.853*
ASA-PS (grades)	2.0 [2.0, 2.0]	2.0 [2.0, 2.0]	0.731*
Preop SF-36			
PF	40 [15, 60]	45 [25, 60]	0.495*
RP	31.3 [6.3, 56.3]	37.5 [18.8, 56.3]	0.439*
BP	41 [22, 52]	31 [22, 41]	0.073*
GH	50 [32, 60]	45 [35, 62]	0.701*
VT	37.5 [18.8, 56.3]	43.8 [25, 62.5]	0.287*
SF	50 [25, 87.5]	50 [37.5, 62.5]	0.416*
RE	41.7 [25, 75]	50 [25, 75]	0.602*
MH	55 [40, 70]	55 [35, 70]	0.618*
MCS	39.9 [32.7, 53.8]	40.9 [31.2, 51.3]	0.856*

The continuous variables are represented by the median with 1st and 3rd quartiles.

*Mann-Whitney U test, #Chi-squared test.

ASA-PS: American Society of Anesthesiologists Physical Status, BMI: body mass index, BP: bodily pain, GH: general health perceptions, MCS: mental component summary, MH: mental health, PF: physical functioning, RE: emotional role limitations, RP: physical role limitations, SF-36: short form-36, SF: social functioning, VT: energy/vitality.

(p<0.001), SF-36 SF (p<0.001), and SF-36 RE (p<0.001, Table 3). However, there were no significant differences in the preoperative c-JOA score and VAS scores. No combination included in the subsequent linear regression analysis in both cervical and lumbar cohorts showed a strong correlation. In the linear regression analysis adjusted with age and gender, the SF-36 SF (p<0.001) and SF-36 RE (p=0.013) were the significant variables relating to MCS improvement independently (Table 3). In contrast, in the lumbar cohort, the univariate analysis demonstrated that there were significant correlations between MCS improvement and VAS of low back pain (p=0.031) and six subdomains of SF-36 (BP: p=0.025, GH: p=0.004, VT: p<0.001, SF: p=0.001, RE: p<0.001, and MH: p<0.001, Table 4). In addition to these variables, the SF-36 RP was included in the subsequent multivariate linear regression analysis. No combination included in the subsequent linear regression analysis in both cervical and lumbar cohorts showed a strong correlation. In the results of the linear regression analysis, the VAS scores of low back pain (p=0.044), SF-36 RP (p=0.043), and RE (p=0.018) were demonstrated as the independent variables significantly relating to MCS improvement in the lumbar cohort (Table 4).

Table 2. Comparison of Individual Mental Component Summary Improvement.

	Adjusted cervical cohort (n=85)	Adjusted lumbar cohort (n=85)	p-value
Improvement>MCID	40 (47.1%)	42 (49.4%)	0.878#
Improvement ≤ MCID	45 (52.9%)	43 (50.6%)	

MCID was defined as 4.0 points in the current study.

#Paired-t test.

MCID: minimal clinically important difference.

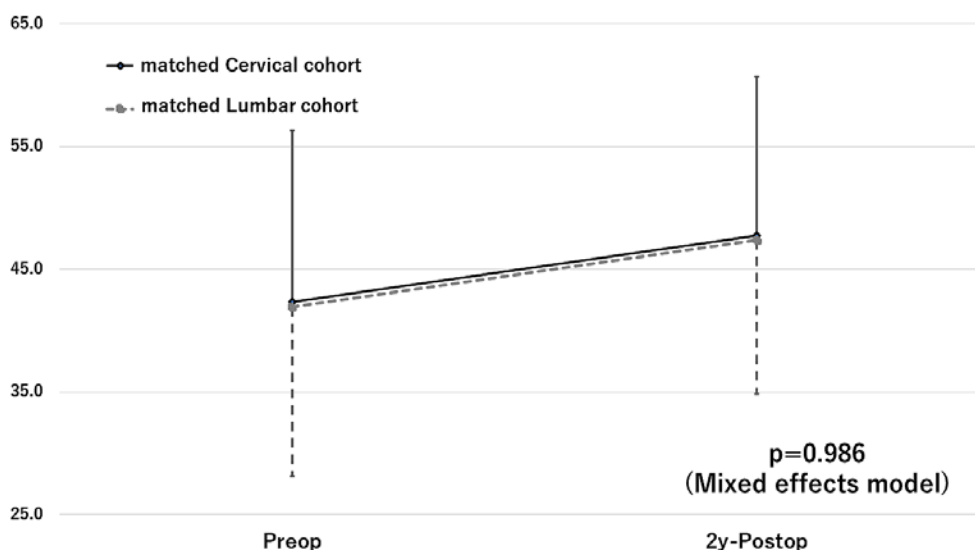


Figure 2. A comparison of the mental component summary improvement.

Table 3. The Correlation of Mental Component Summary Improvement and Preoperative Variables in the Cervical Cohort (n=121).

Explanatory variables	Univariate (Pearson correlation coefficients)		Multivariate (Liner regression analysis)	
	r	p-value	β	p-value
c-JOA score	-0.09	0.319		
VAS				
Neck pain	-0.09	0.428		
Arm pain	-0.16	0.145		
SF-36				
PF	-0.11	0.220		
RP	-0.26	0.004	0.16	0.099
BP	-0.21	0.204		
GH	-0.13	0.167		
VT	-0.35	<0.001	0.12	0.342
SF	-0.47	<0.001	-0.37	<0.001
RE	-0.42	<0.001	-0.32	0.013
MH	-0.43	<0.001	-0.24	0.058

Linear regression was adjusted with age and gender. The value of R^2 was 0.33. c-JOA score: cervical Japanese Orthopaedic Association score, BP: bodily pain, GH: general health perceptions, MH: mental health, PF: physical functioning, RE: emotional role limitations, RP: physical role limitations, SF-36: Short form-36, SF: social functioning, VAS: visual analog scale, VT: energy/vitality.

Discussion

The current study found that the MCS improvement showed no significant difference between cervical and lumbar decompression surgery; approximately 50% of the patients could achieve meaningful MCS improvement. Furthermore, we demonstrated that the predictive factors for MCS improvement were different between the lumbar and cervical cohorts: SF-36 SF and SF-36 RE in cervical surgery and lower back pain, SF-36 RP, and SF-36 RE in lumbar surgery.

The aim of surgery, either cervical or lumbar, in patients with spinal stenosis is to improve or prevent further deterioration of neurological symptoms, pain, and/or numbness that result in the improvement of physical health-related QOL. However, such effort does not always result in the significant improvement of mental health-related QOL^{17,18}. In accordance with the previous study, the current results demonstrated that the improvement of mental well-being was independent of the severity of preoperative neurological symptoms in both lumbar and cervical cohorts. However, the current results also demonstrated that the mental health-related QOL improved significantly, and there was a close resemblance in the improvement between cervical and lumbar decompression surgery. As postoperative mental well-being can significantly impact the patient's surgical satisfaction², it is critical to know the factors related to mental well-being. This can establish interventions aimed at improving mental well-being before or after spine surgery.

Table 4. The Correlation of Mental Component Summary Improvement and Preoperative Variables in the Lumbar Cohort (n=111).

Explanatory variables	Univariate (Pearson correlation coefficients)		Multivariate (Liner regression analysis)	
	r	p-value	β	p-value
l-JOA score	0.11	0.304		
VAS				
Back pain	-0.22	0.031	-0.20	0.044
Leg pain	-0.14	0.171		
SF-36				
PF	0.10	0.316		
RP	0.16	0.099	-0.35	0.043
BP	0.21	0.025	-0.40	0.690
GH	0.27	0.004	0.04	0.766
VT	0.33	<0.001	-0.08	0.686
SF	0.32	0.001	0.12	0.381
RE	0.35	<0.001	0.48	0.018
MH	0.42	<0.001	0.30	0.081

Linear regression was adjusted with age and gender. The value of R^2 was 0.38. l-JOA score: lumbar Japanese Orthopaedic Association score, BP: bodily pain, GH: general health perceptions, MH: mental health, PF: physical functioning, RE: emotional role limitations, RP: physical role limitations, SF-36: Short form-36, SF: social functioning, VAS: visual analog scale, VT: energy/vitality.

Current results revealed that there were some predictive factors for the improvement in mental well-being. One of the predictors was common, whereas the rest were different between cervical and lumbar surgery, thereby providing clues that could be used to develop interventions to improve a patient's mental well-being. The common variable between the two cohorts was SF-36 RE; however, the relations of RE and mental well-being improvement were inconsistent between the lumbar and cervical cohorts. As SF-36 RE was defined as "the limitations in usual role activities because of emotional problems," this result may reflect the emotional nature of the patients that cannot be addressed by spinal surgeons. Although future studies are required to validate our hypothesis, RE may not be considered the key for a novel intervention to improve the mental well-being after surgery for spinal surgeons.

Some interesting findings in the current study include the differences in the predictive factors between the cervical and lumbar cohorts. In the cervical cohort, the preoperative severity of myelopathy and pain was not the significant predictive variable. Meanwhile, in the lumbar cohort, preoperative back pain was a significant variable correlating with the improvement in mental well-being. Previous reports identified a strong correlation between low back pain and poor mental health¹⁹. Although lifestyle factors such as smoking, obesity, and low levels of physical activity have been reported to be associated with the occurrence of low back pain episodes, clear mechanisms of the relationship between low back pain and mental health have not been well established²⁰⁻²². However, the current results suggest that focused

intervention for lower back pain after surgery may improve the mental well-being of patients who underwent lumbar decompression surgery.

The differences of the predictor in the SF-36 subdomains were also interesting. In the lumbar cohorts, preoperative SF-36 RP, which was defined as limitations in usual role activities because of physical health problems, was a significant predictor. Meanwhile, in the cervical cohort, preoperative SF-36 SF, which was defined as limitations in social activities because of physical or emotional problems, was the significant variable. Although both factors were parameters of daily activity, this difference can indicate that the personal activity itself was the important factor in the lumbar cohorts; however, a social relationship via a personal activity was the key factor in the cervical cohort. Considering the current results in our daily clinical setting, interventions for personal activities, such as physical training, can be effective for the improvement in the mental well-being of patients who underwent lumbar decompression surgery. On the other hand, interventions for rebuilding or creating new social relationships can be effective for the improvement in the mental well-being of patients who underwent cervical decompression surgery.

Several limitations to the present study need to be addressed. First, its retrospective nature makes it difficult to exclude bias, especially regarding the referral for a certain surgical procedure, the surgical techniques utilized, and selection bias. In addition, although we analyzed the MCS of the SF-36 as the indicator of mental well-being, it should be analyzed in a multifaceted manner, and the current result should be validated by further studies that consider other aspects. Secondly, all the patients were treated with decompression surgery without fusion. The patients treated with another surgical method, such as anterior cervical discectomy and fusion in the cervical spine and posterior lumbar interbody fusion, should be evaluated. Especially, as preoperative lower back pain was the predictive factor for the improvement of the mental well-being of patients in the lumbar spine cohort, the current results may be tested in patients who underwent lumbar fusion surgery. Finally, the study period, 2009–2013, was relatively old. However, we believe that the current results may help physicians better understand the postoperative changes in the mental well-being of patients and may help develop other interventions for further improvement of postoperative well-being.

In conclusion, although there was no significant difference in the improvement of mental well-being between the patients who underwent cervical and lumbar decompression surgery, less than 50% of the patients in both groups could achieve a meaningful improvement in their mental well-being. Preoperative back pain and personal activity were the independent predictors in the patients who underwent lumbar decompression surgery; meanwhile, social relationship was the only predictor in patients who underwent cervical decompression surgery. These results can be clues to help develop novel interventions to further improve the mental

well-being of patients after spinal surgery.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

Sources of Funding: No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Author Contributions: All the authors participated in the study design, writing, and preparing of the manuscript. All authors have read, reviewed, and approved the article.

Ethical Approval: The study protocol was approved by the Institutional Review Board of Osaka City University (no.3170).

Informed Consent: Informed consent was obtained from all participants in this study.

Declaration: The submitted manuscript does not contain any information about medical drugs.

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