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The influence of preoperative mental health on clinical outcomes after laminectomy in patients with lumbar spinal stenosis

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ABSTRACT

Objective: The influence of preoperative mental health on health-related quality of life (HRQOL) in patients with lumbar spinal stenosis (LSS) remains unclear. This study aims to investigate the influence of preoperative mental health HRQOL after laminectomy in patients with LSS.
Patients and Methods: We retrospectively reviewed 122 patients who had lumbar spinous process splitting laminectomy (LSPSL) for LSS. We assessed clinical information; Japanese Orthopedic Association (JOA) score; numerical rating scale (NRS) for low back pain, for leg pain, and for leg numbness; Zurich Claudication Questionnaire (ZCQ); JOA Back Pain Evaluation Questionnaire (JOABPEQ); Roland-Morris Disability Questionnaire (RMDQ); and Short Form 8 (SF-8) as patient reported outcomes. Patients were divided into two groups (Group L ≤ 36.2 points and Group NL > 36.2 points) based on the results of the preoperative mental health (MH) score in SF-8 to examine the influence of MH in LSS. We compared the HRQOL between the two groups postoperatively.
Results: The JOA score, NRS, and ZCQ score significantly improved after surgery. HRQOL outcomes including JOABPEQ, RMDQ, and SF-8 showed that the LSPSL improved not only the physical but also the mental function in patients with LSS. All HRQOL outcomes in Group L exhibited significantly worse scores preoperatively; however, no significant differences between two groups were found postoperatively.
Conclusions: LSPSL greatly reduced low back pain, leg pain, and leg numbness. LSPSL resulted in a significant improvement based on HRQOL questionnaires even in patients with preoperative depressive mood. Not only the physical status but also the mental health may improve after LSPSL even in patients with LSS with a depressive mood preoperatively.

1. Introduction

Lumbar spinal stenosis (LSS) causes low back pain (LBP), leg pain, neurological deficits as manifested by functional impairment of the lower limbs, and bowel and bladder dysfunctions. These symptoms could greatly affect the patients' quality of life [1]. Clinical, neurological, and radiological findings have been evaluated as diagnostic parameters and outcome measures in LSS [2,3]. However, they could not directly reflect the outcomes, such as functional status and symptoms, after surgery [1]. To overcome this problem, self-administered questionnaires (so-called patient-reported outcome measures: PROMs) are used to evaluate health-related quality of life (HRQOL) after surgery.

HRQOL assessment is recently considered essential in the evaluation of neurological and spinal disorders [4]. Although the application of HRQOL instruments to measure outcomes has been expanded, these tools have not been widely used as predictors of treatment effectiveness [5]. Moreover, although the relationship between preoperative mental health and outcomes in lumbar surgeries was investigated in previous studies [5–11], the studies included patients with fusion surgery; particularly, they evaluated the correlation between depression and chronic LBP. Hence, in this study, we focused on patients who had laminectomy without fusion. Moreover, these studies have reported that psychological distress might negatively affect postoperative outcomes, however, we often encounter the patients who improve not only the physical status but also the mental status after decompression surgery

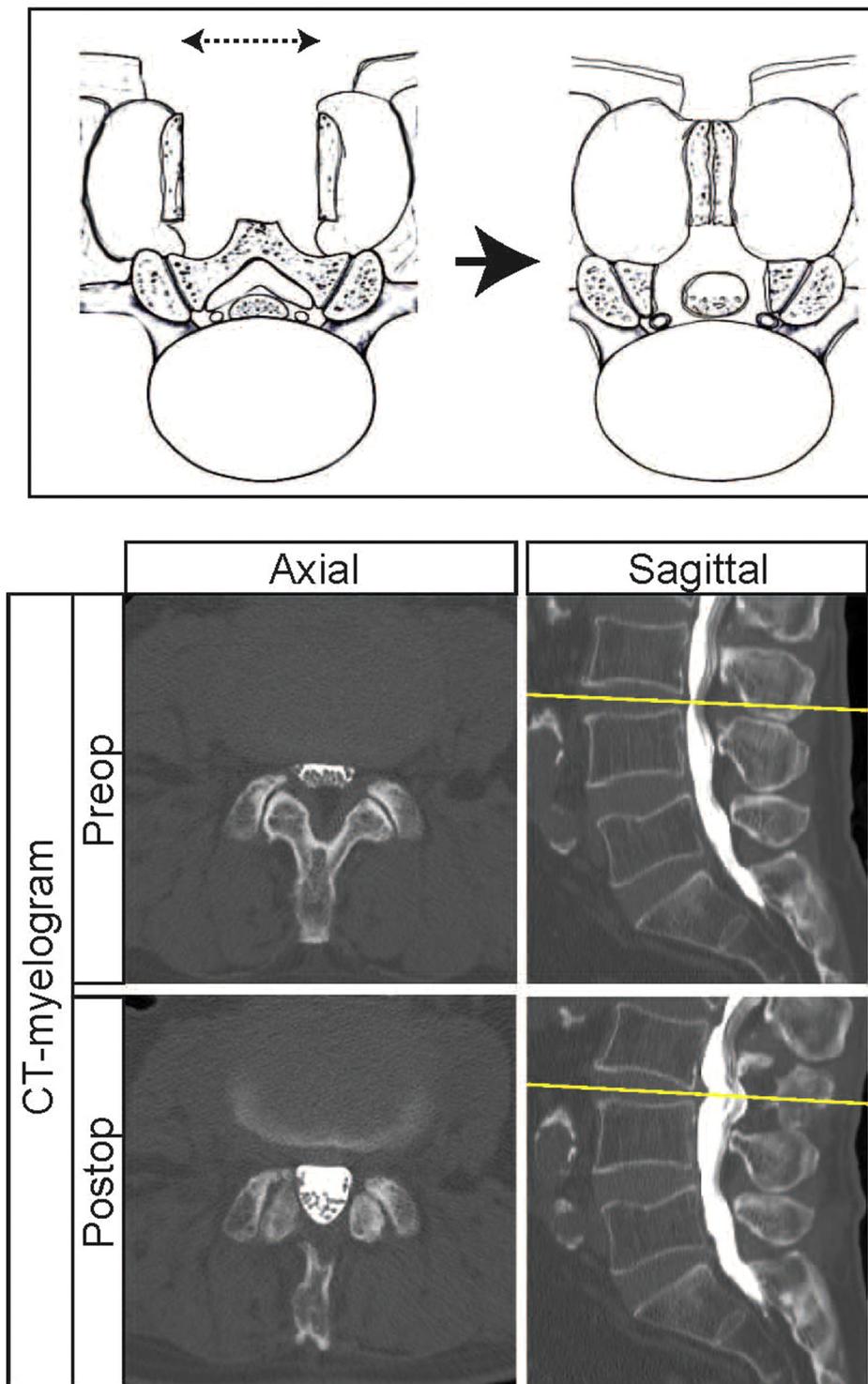# The scheme of the surgical procedure in LSPSL

Fig. 1. The scheme of the surgical procedure, pre- and postoperative CT-myelograms.

in LSS. We analyzed data on several PROMs for HRQOL and investigated the influence of preoperative mental health on HRQOL outcomes after laminectomy without fusion in patients with LSS.

2. Materials and methods

2.1. Patients and clinical assessments

We retrospectively reviewed patients who had lumbar spinous process splitting laminectomy (LSPSL) [12] without fusion for LSS between June 2014 and March 2016. LSPSL for LSS that was performed in patients with no intervertebral instability (i.e., < 10° of intervertebral

Table 1
Patient demographics.

	Total	Group L	Group NL	p
Number of cases	122	47	75	–
Age (years)	69.5 ± 10.2	70.6 ± 9.41	68.6 ± 10.7	0.35
Sex (M:F)	77:45	23:24	54:21	0.01*
BMI (kg/m^2)	23.8 ± 3.38	26.0 ± 4.31	24.7 ± 2.95	0.72
EBL (mL)	57.3 ± 55.0	59.2 ± 52.5	56.2 ± 56.9	0.76
Operating time (min)	74.7 ± 33.2	74.2 ± 30.8	75.4 ± 34.7	0.89
Number of resected laminae	1.69 ± 0 89	1.74 ± 1.03	1.68 ± 0.79	0.64
Follow-up (months)	25.2 ± 3.58	26.0 ± 4.31	24.7 ± 2.95	0.05
ASA-PS	1.91 ± 0.43	1.94 ± 0.48	1.89 ± 0.39	0.59

Mean ± standard deviation.
ASA-PS, American Society of Anesthesiologists physical status classification; BMI, body mass index; EBL, estimated blood loss.

angle change in preoperative functional radiographs and no spondylolisthesis ≥ grade 2) and in those with scoliosis with Cobb angle < 15° were selected. Patients followed for at least 21 months and who had preoperative and final follow-up questionnaire data were eligible for inclusion in this study. Informed consent was obtained from all participants. Our hospital institutional review board approved this study.

The mean mental health score in SF-8 was 50.0 ± 6.9 based on the standardized mean in the general Japanese population [13]. In our study, no patients declared treatment history for depression. Thus, we defined the threshold of depressive mood as < 36.2 points (mean – 2 × standard deviation). A total of 122 patients met the inclusion criteria; they were divided into two groups according to their mental health score in SF-8: Group L (≤36.2 points) and Group NL (> 36.2 points), because calculations into baseline levels widely used this threshold, and the numerous papers use this calculation [14–16]. Moreover, data on the following were obtained: age, sex, body mass index (BMI), estimated blood loss (EBL), time in surgery, follow-up period, and American Society of Anesthesiologists physical status classification (ASA-PS).

The Japanese Orthopedic Association (JOA) score, numerical rating scale (NRS) for LBP, leg pain, and leg numbness, and the Zurich Claudication Questionnaire (ZCQ) were evaluated preoperatively and at the final follow-up as clinical outcomes. A higher JOA score indicated better functioning. ZCQ consisted of physical function, symptom severity, and patient satisfaction and was used to evaluate the severity of spinal stenosis symptoms [17]. A lower score for NRS and the ZCQ indicated a better outcome. The JOA score recovery rate was calculated as follows: (postoperative JOA score – preoperative JOA score)/(29 – preoperative JOA score) × 100 (%) [18].

The JOA Back Pain Evaluation Questionnaire (JOABPEQ) [19], and Short Form 8 (SF-8) Health Survey [20] were used to evaluate the HRQOL. Roland-Morris Disability Questionnaire (RMDQ) was used to evaluate the disability and physical function [21], Data on the HRQOL questionnaires administered preoperatively and at the final follow-up were obtained. The JOABPEQ scores reflected a health profile of five discrete scores by calculating with its own algorism, which range from 0 to 100; a higher score indicated better outcome functioning. The RMDQ scores ranged from 0 to 24, with a lower score indicating better physical functioning. The SF-8 reflected a health profile of eight discrete scores, which were further classified as physical component summary (PCS) and mental component summary (MCS) by calculating its own algorism; a higher score represented better outcome functioning.

2.2. Surgical procedures

The operation was performed with the patient under general anesthesia and in the prone position. Decompression was conducted using LSPSL, as previously reported [12]. Briefly, a posterior midline skin incision was made to expose the cortex of the tip of the spinous process.

The spinous process was drilled at the midline using a high-speed drill with a fine 3-mm diamond-tipped bur. Thereafter, the spinous process was split to the base and detached from the lamina using a Cobb elevator. A high-speed drill was used to remove the lamina and a Kerrison rongeur to remove the ligamentum flavum at the cranial and caudal ends of the intended laminar expansion. After the affected nerve roots and the dural sac were decompressed, the halves of the split spinous process were recapped using a strong non-absorbable suture (Fig. 1). Drainage tube was removed after 2–3 days depending on the amount of the drainage. Postoperative ambulation was started without a brace on the day after the surgery.

2.3. Statistical analysis

Values are expressed as mean ± standard deviation. Differences in baseline characteristics were tested using Student's t-test for continuous variables and chi-squared test for categorical variables. Non-normally distributed variables were compared using the Mann–Whitney non-parametric U test. Correlations between parameters were calculated using Pearson's rank correlation coefficients. A p value < 0.05 was considered statistically significant. We used GraphPad Prism software (version 6.0c; GraphPad Software Inc., CA, USA) for all analyses.

3. Results

This study included 77 men and 45 women, with an average age of 69.5 ± 10.2 (range 27–89) years. The mean BMI was 23.8 ± 3.38 (range 17.0–35.6) kg/m^2. The mean EBL was 57.3 ± 55.0 (range 5–280) mL, the mean surgery time was 74.7 ± 33.2 (range 29–193) min, the mean number of resected laminae was 1.69 ± 0.89 (range 1–5), and the mean clinical follow-up was 25.2 ± 3.58 (range 24–37) months. The mean ASA-PS was 1.91 ± 0.43 (range 1–3) (Table 1).

For the clinical outcomes, the JOA score, NRS, and ZCQ significantly improved after surgery (p < 0.0001), and JOA recovery rate was 74.2 ± 21.6% (Table 2). Moreover, HRQOL outcomes including JOABPEQ showed that the LSPSL improved not only the physical but also the mental function in patients with LSS (p < 0.0001). The RMDQ and SF-8 also showed a significant improvement after surgery (p < 0.0001) (Fig. 2).

Forty-seven patients were allocated in Group L and 75 in Group NL. Although the male-to-female ratio was significantly higher in Group L (p = 0.01), patient demographics showed no significant differences in other parameters between the two groups (Table 1). NRS for LBP and leg numbness and ZCQ were significantly higher in Group L preoperatively (p = 0.04, p = 0.03, p < 0.01, respectively); however, no significant differences between the two groups postoperatively were found (Table 3). For HRQOL, mental health, walking ability, and social life function scores in JOABPEQ were significantly lower in Group L preoperatively (p < 0.01); however, no significant differences between

Table 2
Clinical outcomes.

	Preoperative	Postoperative	p
JOA score (pts)	16.2 ± 4.69	25.8 ± 2.98	< 0.0001
JOA recovery rate (%)	74.2 ± 21.6		–
NRS (pts)			
Low back pain	5.75 ± 2.56	2.62 ± 2.29	< 0.0001
Leg pain	6.02 ± 2.78	2.11 ± 2.16	< 0.0001
Leg numbness	5.75 ± 2.77	2.05 ± 2.22	< 0.0001
ZCQ (pts)			
Physical function	21.5 ± 4.92	14.5 ± 4.66	< 0.0001
Symptom severity	13.2 ± 3.48	8.23 ± 2.71	< 0.0001
Patient satisfaction	–	11.2 ± 4.03	–

Mean ± standard deviation.
JOA: Japanese Orthopedic Association; NRS, numerical rating scale; ZCQ, Zurich Claudication Questionnaire; pts, points.
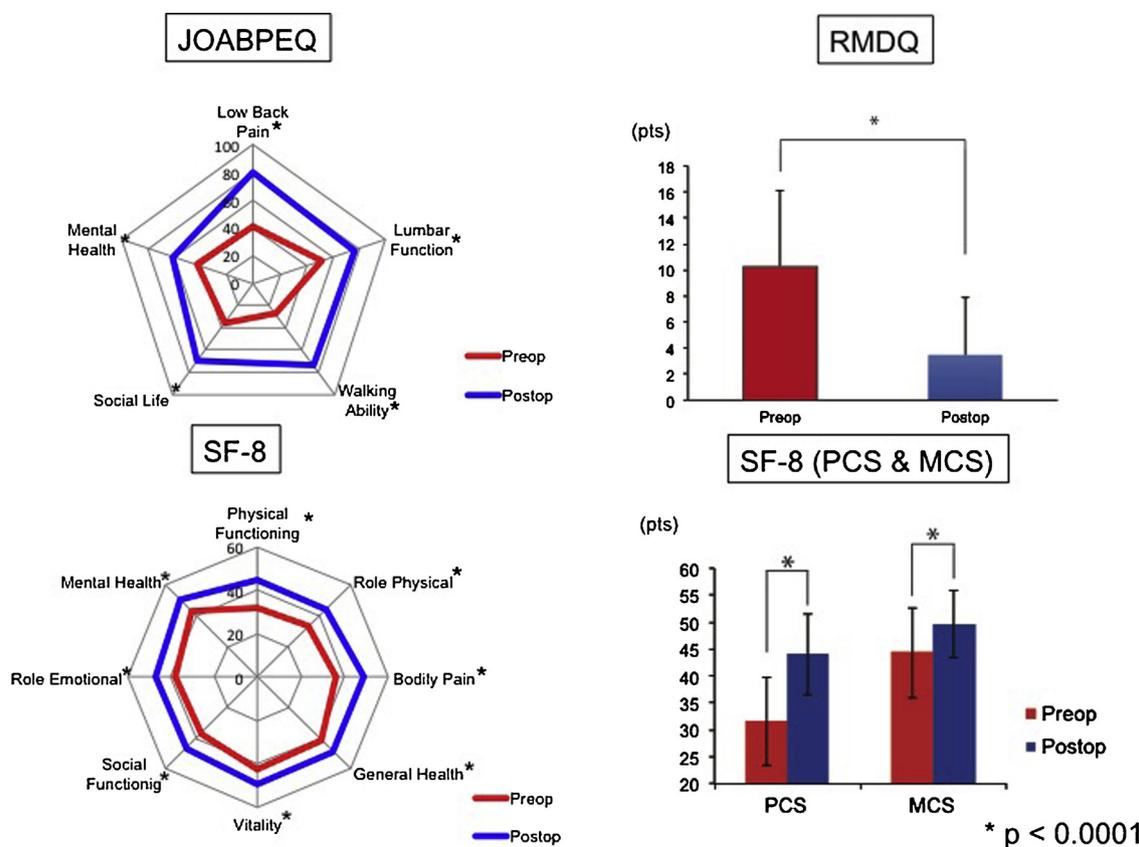
Fig. 2. Changes in health-related quality of life outcomes after surgery.
JOABPEQ, Japanese Orthopedic Association Back Pain Evaluation Questionnaire; PCS, physical component summary; MCS, mental component summary; RMDQ, Roland-Morris Disability Questionnaire; pts, points; SF-8, Short-Form 8.

the two groups postoperatively were noted (Fig. 3). Although RMDQ showed a significantly higher score ($p < 0.0001$) in Group L preoperatively, which indicates a worse outcome, no significant differences between the two groups were found postoperatively (Fig. 4). Similarly, all eight discrete scores, including physical functions, in SF-8 were also significantly lower in Group L preoperatively ($p < 0.0001$); no significant differences were noted between the two groups postoperatively. Furthermore, PCS and MCS in SF-8 also showed significantly lower scores preoperatively in Group L ($p < 0.05$ and $p < 0.0001$, respectively); no significant differences postoperatively were found (Fig. 5).

Of 122 patients, 6 patients (4.9%) had < 36.2 points both pre- and postoperatively. The NRS, ZCQ, JOABPEQ, RMDQ, and PCS and MCS in

SF-8 of these six patients showed no significant differences pre-operatively; however, their clinical scores were significantly lower postoperatively than those of the other patients ($p < 0.0001$).

4. Discussion

In this retrospective analysis of prospectively collected data, we demonstrated that LSPSL greatly reduced LBP, leg pain, and leg numbness. LSPSL resulted in a significant improvement not only in physical but also in mental function in patients with LSS. Contrary to previous studies [5–8], our study showed that preoperative mental health did not affect the HRQOL outcome in patients with LSS.

Derby et al. reported that psychological and emotional distress

Table 3
Clinical outcomes according to mental health score in SF-8.

	Preoperative			Postoperative		
	Group L	Group NL	p	Group L	Group NL	p
JOA score (pts)	15.5 ± 4.60	16.5 ± 4.73	0.23	25.3 ± 3.38	26.0 ± 2.67	0.17
JOA recovery rate (%)	–			70.6 ± 24.9	76.3 ± 19.1	0.13
NRS (pts)						
Low back pain	6.35 ± 2.61	5.39 ± 2.47	0.04*	2.53 ± 2.19	2.70 ± 2.36	0.75
Leg pain	6.63 ± 2.87	5.64 ± 2.67	0.05	2.22 ± 2.01	2.06 ± 2.26	0.63
Leg numbness	6.41 ± 2.79	5.33 ± 2.70	0.03*	2.03 ± 2.42	2.09 ± 2.10	0.95
ZCQ (pts)						
Physical function	23.2 ± 4.78	20.5 ± 4.73	< 0.01*	15.1 ± 4.30	14.2 ± 4.86	0.27
Symptom severity	14.4 ± 3.63	12.5 ± 3.20	< 0.01*	8.42 ± 2.67	8.15 ± 2.75	0.53
Patient satisfaction	–			10.8 ± 4.06	11.9 ± 3.92	0.10

Mean ± standard deviation.
JOA, Japanese Orthopedic Association; NRS, numerical rating scale; ZCQ, Zurich Claudication Questionnaire; pts, points.
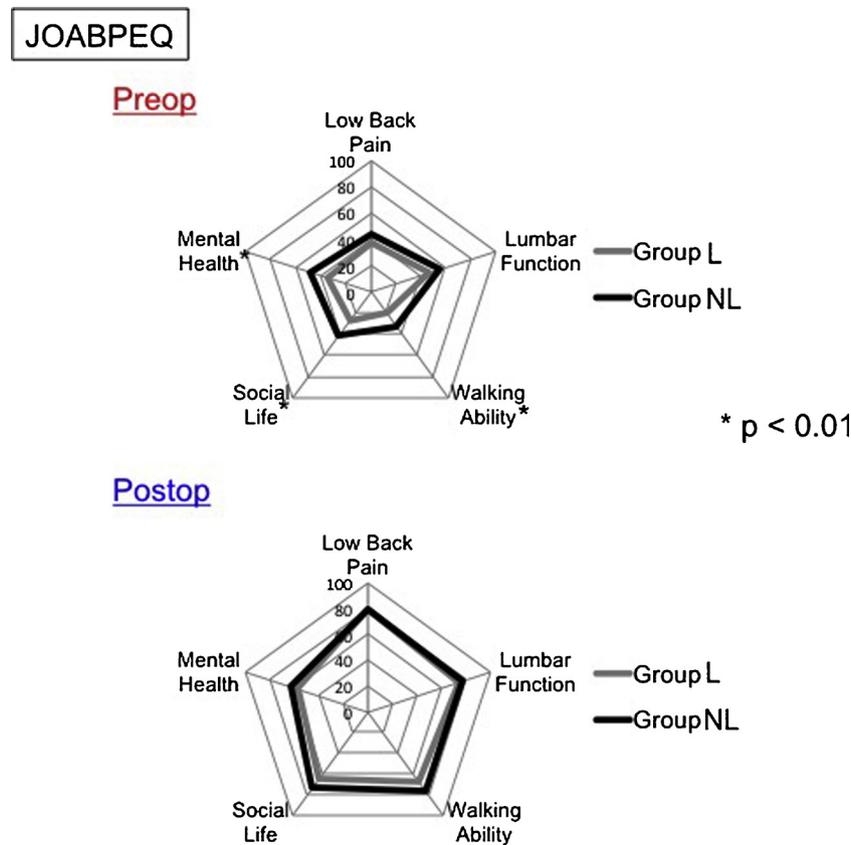 * p < 0.05.

Fig. 3. JOABPEQ according to the mental health score in SF-8.
JOABPEQ: Japanese Orthopedic Association Back Pain Evaluation Questionnaire.
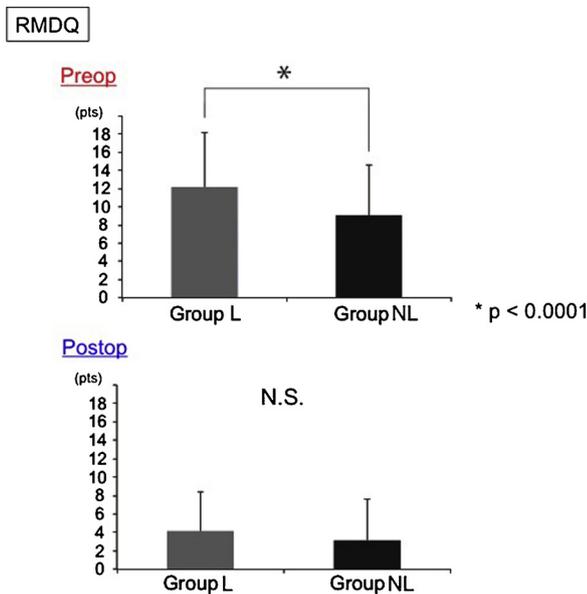

Fig. 4. RMDQ according to the mental health score in SF-8.
pts, points; RMDQ, Roland-Morris Disability Questionnaire.

might negatively affect postoperative outcomes [8]. Other studies also described that patients with good preoperative MCS in SF-8 are more likely to show improvement after lumbar surgery [5]. Several case series have also reported the effects of psychological disorders on the treatment outcomes of chronic LBP [9–11]. However, these studies included patients undergoing fusion surgery, and the assessment of mental health was further complicated by the clinical heterogeneity of lumbar surgical patients. Particularly, patients who had fusion surgery experienced preoperative pain much longer and had more previous surgeries than those undergoing laminectomy without fusion [22]. Thus, we focused only on patients who had laminectomy without fusion in this study.

We defined the threshold of depressive mood as < 36.2 points (mean − 2 × standard deviation) in this study since the mean mental health score in SF-8 is 50.0 ± 6.9 in the standardized mean of the general Japanese population [13]. Carreon et al. reported significant correlations between PCS and Oswestry Disability Index (ODI; one of the HRQOL questionnaires) improvement as well as back pain, BMI, age, and smoking status. They attempted to determine the threshold values for MCS, PCS, and ODI that are predictive of clinically significant difference; however, the values could not be determined [5]. In addition, the definition of depression mood in our study should be adequate, as the tendency in other preoperative HRQOL questionnaires (i.e., JOABPEQ and RMDQ) was similar between Groups L and NL. We also analyzed the correlation between the preoperative mental health score in SF-8 and the other PROMs. We have found that preoperative mental health score in SF-8 correlate with all the other preoperative PROMs in this study but not with postoperative PROMs. These results suggested that the preoperative mental health might not affect the HRQOL outcomes.

Not only mental health but also physical function was significantly worse preoperatively in Group L than in Group NL, which could be associated with a previous report that worse mental health worsens physical function [23,24]. Trivedi reported that physical pain and depression have a deeper biological connection than a simple cause and effect; the neurotransmitters that influence both pain and mood are serotonin and norepinephrine. Moreover, vague aches and LBP are often the presenting symptoms of depression, which also include chronic joint pain, limb pain, back pain, and psychomotor activity
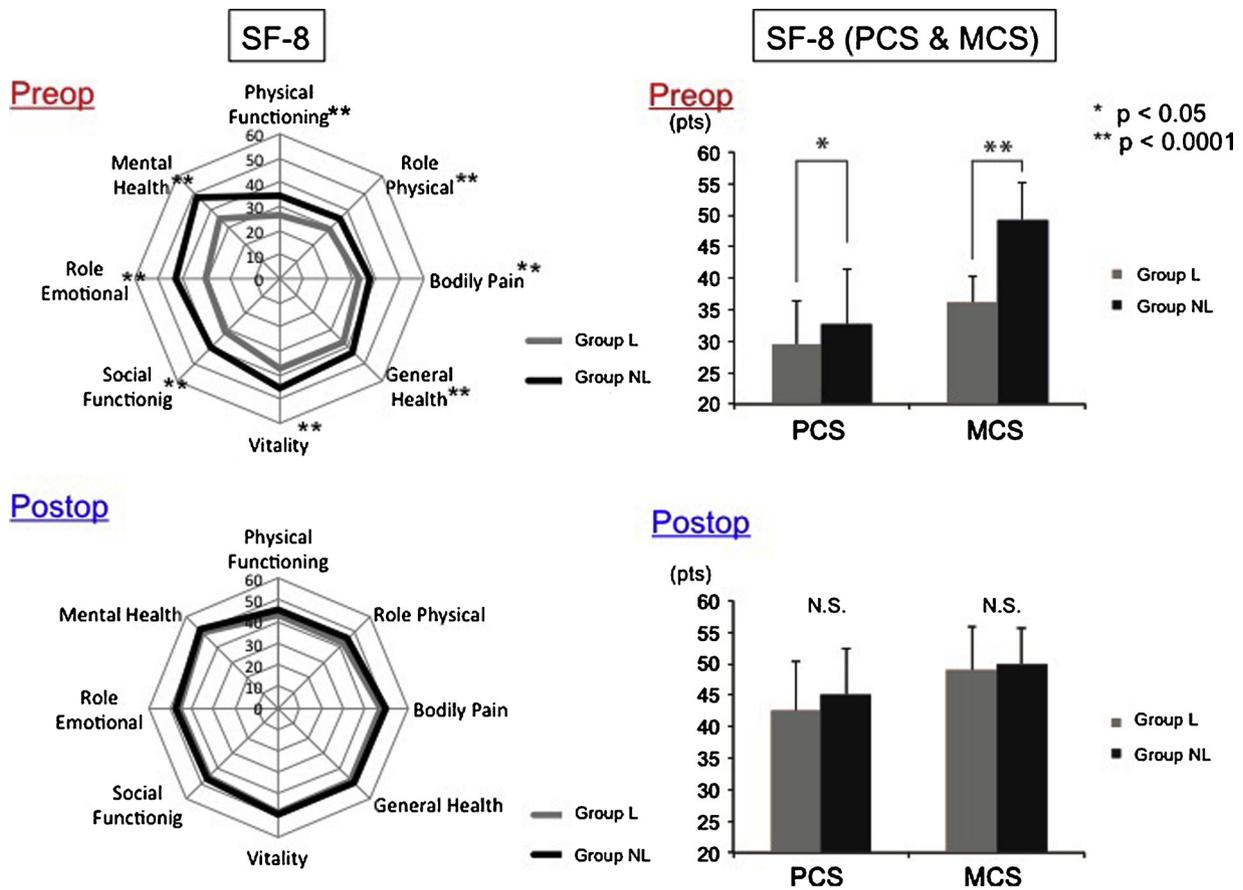
Fig. 5. Discrete scores in SF-8 and PCS and MCS.
MCS, mental component summary; N.S., not significant; PCS, physical component summary; pts, points; SF-8, Short-Form 8.

changes [23,25,26]. Nevertheless, worse physical health could worsen mental health. A previous study demonstrated that depression is more severe in patients with severe LBP than in those with mild or moderate LBP [27]. Although we could not find significant differences in the preoperative JOA score between two groups, previous study have reported that the objective measures have clearly influenced by mental health [28]. Therefore, more simple and standardized objective measures such as Time Up and Go (TUG) test might be able to catch these differences more precisely. Steinen et al. have also reported that the reduction of mental HRQoL represents a significant bias to the subjective patient evaluation by means of PROMs, however, objective outcome measures that evaluate functional mobility of patients were found to be less influenced by mental health [28]. These findings basically matched the results in our study: no significant differences were found between Groups L and NL postoperatively in all HRQOL outcomes, although all preoperative HRQOL outcomes in Group L exhibited worse scores. These results indicated that the preoperative mental health of most patients is worse because of impaired preoperative activities of daily living. Thus, not only the physical status but also the mental health may improve after LSPSL even in patients with LSS with a depressive mood preoperatively.

Of 122 patients, 6 (4.9%) had < 36.2 points for the mental health score in SF-8 both pre- and postoperatively. Although other clinical status of these patients showed no significant difference preoperatively, they had significantly lower clinical scores than other patients postoperatively. They possibly had some psychological problems, such as severe depression, and/or were misdiagnosed as having LSS. These results suggested that the most patients in Group L might have a situational depression mood, which would be expected to improve if the symptoms improved. Nevertheless, a further study has to be conducted to identify the preoperative diagnostic parameters. To more effectively

understand the disability and QOL, spine surgeons must consider the dynamic nature of the relationships among pain, disability, and mental health.

PROMs are commonly used to evaluate health-related quality of life (HRQOL) after surgery. However, a statistically significant change in scores does not necessarily equate to a change in an individual's score that either the patient or the clinician would identify as being an important change in the patient's health. Minimally clinically important difference (MCID) is an important concept to determine if the medical intervention improves the outcomes in patients. Previous studies had validated MCIDs in RMDQ and NRS, although these have assessed for different health status and different populations [29–31]. These showed the reduction of 30% in questionnaire scores should be consistent across samples, conditions, and instruments [32]. Even though MCID should be used to identify the difference in the medical intervention, not to identify the difference between two groups before treatment since the two groups have the different population and conditions. In this study, we should note the NRS for LBP and leg numbness and ZCQ were significantly higher in Group L preoperatively compared with Group NL, however, the differences between two groups were less than 30%.

Strengths of this study are first, we applied a range of validated outcome measures, including the JOA score, NRS for LBP, leg pain, and leg numbness, ZCQ, JOABPEQ, RMDQ, and the SF-8 Health Survey followed for slightly more than 2 years postoperative. Furthermore, the multiple outcome measures demonstrated the consistency of the results.

This study had several limitations, including its retrospective nature. We used the pragmatic cutoff strategy to define the threshold of depressive mood while we did not use the other scores for validating the depression such as PHQ-9 [33]. Present study included the patients who provided 2-year follow-up data, however, it could be a selection

bias as patients who suffered from mental health disorders might be less to provide the data. Moreover, we did not evaluate global spinal alignment, which could also affect functional outcomes and QOL, and we could not evaluate past psychological illness, specifically depression, because no patients declared treatment history for depression in this study. Differences in postoperative medication and rehabilitation could have also affected the clinical outcomes, which were not investigated in this study.

5. Conclusion

LSPSL greatly reduced LBP, leg pain, and leg numbness. LSPSL also resulted in a significant improvement in all HRQOL questionnaires even in patients with preoperative depressive mood. Not only the physical status but also the mental health may improve after LSPSL even in patients with LSS with a depressive mood preoperatively.

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