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ORIGINAL ARTICLE

Outcomes after decompression surgery without fusion for patients with lumbar spinal stenosis and substantial low back pain

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Abstract

Purpose The aim of this study was to evaluate the efficacy of decompression surgery alone for patients with intolerable low back pain.

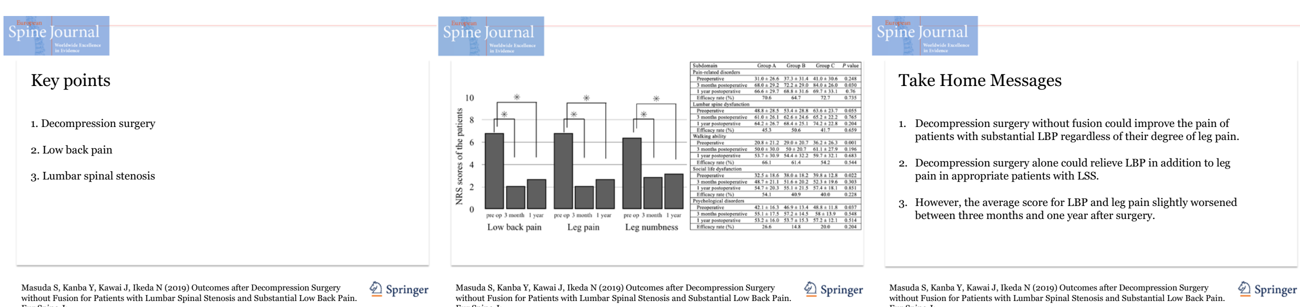
Methods We retrospectively identified 222 patients who underwent spinal decompression without fusion surgery who had substantial preoperative low back pain (preoperative numerical rating scale score ≥ 5). Their clinical outcomes were assessed using the numerical rating scale and the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) preoperatively and at 3 months and 1 year after surgery.

Results At 3 months and 1 year after surgery compared with baseline, there was a significant improvement in the overall mean numerical rating scale scores for low back pain (baseline = 6.8, 3 months = 2.1, 1 year = 2.7), leg pain (6.8, 2.1, 2.7), and leg numbness (6.4, 2.9, 3.2) ($P < 0.05$). The efficacy rate assessed by JOABPEQ was 68.1% for pain-related disorders, 47.0% for lumbar spine dysfunction, 63.3% for walking ability, 48.2% for social life dysfunction, and 21.6% for psychological disorders. When patients were classified into three groups depending on their degree of leg pain (mild, moderate, and severe), there was no significant difference in the efficacy rate between the three groups.

Conclusion Decompression surgery can improve low back pain, regardless of the degree of preoperative leg pain, but the average score for LBP and leg pain slightly worsened between 3 months and 1 year after surgery.

Graphic abstract

These slides can be retrieved under Electronic Supplementary Material.



Keywords Lumbar spinal stenosis · Low back pain · Decompression surgery · Clinical outcomes · Leg pain

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Introduction

Lumbar spinal stenosis (LSS) is a common spinal disease that causes leg pain, low back pain (LBP), claudication, leg numbness, and muscle weakness. Surgical treatment has been demonstrated to be superior to conservative treatment in selected patients [1]. Decompression surgery is one of the most established surgical methods to treat the earlier stages of LSS, although the use of fusion surgery combined with decompression has recently increased [2]. However, there is no established indication for fusion surgery, and the main symptoms of the patients were reported to be important when deciding whether to perform fusion in addition to decompression [3].

Some studies have reported that greater LBP relative to leg pain was related to worse outcomes after decompression without fusion, so patients with substantial back pain are often recommended for fusion surgery [3, 4]. On the other hand, a few studies reported that decompression without fusion had some effect on LBP [5–7]. It remains unclear whether patients with substantial back pain may improve with decompression alone, and whether the degree of concomitant leg pain affects the outcome of decompression surgery for spinal stenosis. In this study, we aimed to investigate the efficacy of decompression-only surgery for patients complaining of substantial LBP.

Materials and methods

This research was approved by the Institutional Review Boards of the authors' affiliated institutions. Between July 2012 and August 2017, 589 patients at our institutions underwent lumbar decompression without fusion for LSS. Of those patients, there were 336 patients with preoperative substantial low back pain [numerical rating scale (NRS) ≥ 5]. The exclusion criteria for this study were (1) history of previous spine surgery, (2) herniotomy performed with decompression, (3) occurrence of vertebral fractures during follow-up, (4) significant unstable spondylolisthesis with progression of slippage > 4 mm or posterior opening > 10°, (5) severe scoliosis with a Cobb angle of > 30°, and (6) incomplete follow-up. A total of 222 patients (130 men and 92 women; age range 31–93 years; mean age 74.6 years) met inclusion criteria with a minimum follow-up of 1 year. Due to incomplete follow-up, 16 patients were excluded. The mean body mass index was 24.5 kg/m^2 (range 17.0–33.8 kg/m^2). The diagnosis of LSS was made based on clinical symptoms including LBP, leg pain, leg numbness, and imaging studies including magnetic resonance imaging or computed tomography myelography. The decision about whether to perform decompression alone or combined with fusion was made by each surgeon after considering the patient's age, performance status, activities of daily life, comorbidity, and the wishes of the patients and their family. For each patient, the decompression level was determined based on imaging studies and neurological examination by each surgeon. Three spine surgeons performed all of the surgeries in this study. Our method of decompression was spinous process-splitting laminectomy [8]. The mean number of levels of decompression was 2.3 ± 0.7. For pain medication, non-steroidal anti-inflammatory drugs were prescribed for every patient.

The clinical assessments were evaluated using the NRS and the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ). We performed the assessments before surgery, 3 months after surgery, and 1 year after surgery. The NRS values included scores for LBP, pain in the buttocks and lower limb(s), and simultaneous numbness in the buttocks and lower limb(s). In addition, we assessed NRS20 pain scores (combined back and leg pain score) [9]. The efficacy rate for all five subdomains of the JOABPEQ (pain-related disorders, lumbar spine dysfunction, walking ability, social life dysfunction, and psychological disorders) for each group was calculated in accordance with the user's guide for the JOABPEQ [10]. If the difference in the functional scores of a domain between two time points increases by 20 points, that function is judged to be effective. After excluding patients whose pretreatment and posttreatment scores are both ≧ 90 points from the analysis, we calculate the effectiveness rate in each group and then perform tests of population proportion. For all patients, standing posteroanterior, lateral, and flexion–extension radiographs were taken before surgery, and at 3 months and 1 year after surgery. We measured lumbar lordosis (the angle between the superior endplate of L1 and S1), lumbar scoliosis, and lumbar range of motion (ROM). Lumbar scoliosis angles were measured by the Cobb method with the apex between L2 and 4. Lumbar ROM was defined by the angle difference in lumbar lordosis between flexion and extension radiographs. The first author, who was not the surgeon treating the patients, performed the measurements. We classified the patients into three groups depending on their preoperative leg pain: group A severe leg pain (leg pain NRS ≥ 8), group B moderate leg pain (4 ≤ leg pain NRS ≤ 7), group C mild leg pain (leg pain NRS ≤ 3).

We used R software version 3.5.1 (R Development Core Team, Vienna, Austria) for statistical analyses. The tests included the Wilcoxon rank sum test for non-normal distribution data, paired Student's *t* test for normal distribution data, and one-way analysis of variance. Values of $P < 0.05$ were regarded as significant.

Results

The overall mean NRS scores for LBP, leg pain, and leg numbness before surgery, 3 months, and 1 year after surgery are shown in Fig. 1.After surgery, there was a significant improvement in LBP, leg pain, and numbness compared with baseline ($P < 0.001$). However, the average score for LBP and leg pain worsened between 3 months and 1 year after surgery ($P < 0.01$). Similarly, NRS20

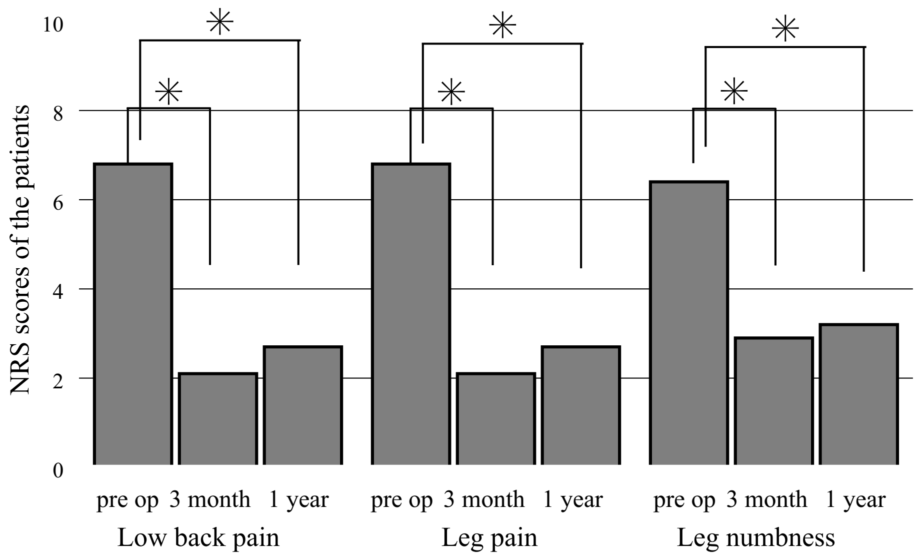

Fig. 1 Change of NRS (low back pain, leg pin and leg numbness) after surgery. Decompression alone surgery significantly improved all NRS scores. Student's *t* test, *$P <$ 0.05. NRS: Numerical rating scale

scores significantly decreased postoperatively (13.7 ± 3.4 to 4.2 ± 3.8 to 5.4 ± 4.5; $P < 0.001$), but slightly increased between 3 months and 1 year follow-up ($P < 0.001$). The efficacy rate was 68.1% for pain-related disorders, 47.0% for lumbar spine dysfunction, 63.3% for walking ability, 48.2% for social life dysfunction, and 21.6% for psychological disorders (Table 1).

When patients were grouped by their degree of preoperative leg pain, all groups were found to have a significant improvement in LBP and NRS20 at 3 months and 1 year after surgery. Group A had more back pain and NRS20 than the other two groups preoperatively. However, postoperatively, there were no significant differences in LBP and NRS20 between the groups (Table 2). All five subdomain scores of JOABPEQ were significantly improved postoperatively in all groups. We found no differences in the efficacy rate between the three groups (Table 3).

Changes in the radiological parameters of all patients are summarized in Table 4. At 3 months after surgery, lumbar ROM was decreased significantly. At 1 year after surgery, the lumbar scoliosis angle was increased significantly ($P < 0.001$) and lordosis tended to improve ($P = 0.052$). We also analysed the relationship between the radiological parameters and the degree of preoperative leg pain, and found no differences between the three groups (Table 5).

Table 1 Patient scores on five subscales of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ)

Pain-related disorders	
Preoperative	34.6 ± 29.3
3 months postoperative	71.4 ± 29.2
1 year postoperative	67.8 ± 30.9
Efficacy rate	68.1
Lumbar spine dysfunction	
Preoperative	52.3 ± 28.5
3 months postoperative	62.1 ± 25.1
1 year postoperative	67 ± 25.9
Efficacy rate	47.0
Walking ability	
Preoperative	25.8 ± 22.3
3 months postoperative	51.2 ± 29.4
1 year postoperative	54.7 ± 31.6
Efficacy rate	63.3
Social life dysfunction	
Preoperative	35.5 ± 18.1
3 months postoperative	50.2 ± 20.7
1 year postoperative	55.2 ± 20.5
Efficacy rate	48.2
Psychological disorders	
Preoperative	44.8 ± 15.0
3 months postoperative	56.3 ± 16.0
1 year postoperative	53.9 ± 15.4
Efficacy rate	21.6

Discussion

Our findings suggest that lumbar decompression without fusion surgery could relieve the pain of patients with LSS, even if they have intolerable LBP. The group with severe preoperative leg pain had significantly more severe LBP than the groups with moderate and mild leg pain. However, at 1 year after surgery, all groups had improved significantly and there were no significant differences in LBP and NRS20 between the groups. This result may suggest that we need to reconsider the proposition that preoperative back pain with LSS needs to be treated with combined fusion surgery and decompression.

Table 2 Patient details and NRS scores by group defined by preoperative leg pain: group A severe leg pain (leg pain NRS ≥ 8), group B moderate leg pain (4 ≤ leg pain NRS ≤ 7), group C mild leg pain (leg pain NRS ≤ 3)

Variable	Group A	Group B	Group C	*P* value
Number of patients	109	88	25	
Sex M/F	58/51	55/33	17/8	
Age	74.8 ± 9.9	75.0 ± 7.5	73 ± 8.0	0.611
BMI	24.0 ± 3.1	25.1 ± 3.2	24.8 ± 3.6	0.05
Number of involved levels	2.2 ± 0.7	2.4 ± 0.7	2.4 ± 0.7	0.01
LBP				
Preoperative	7.6 ± 1.6	6.2 ± 1.2	6 ± 1.0	< 0.001
3 months postoperative	2.2 ± 2.1	2.2 ± 2.0	1.5 ± 1.6	0.270
1 year postoperative	2.8 ± 2.4	2.6 ± 2.4	2.8 ± 2.8	0.566
Leg pain				
Preoperative	8.7 ± 0.8	6.0 ± 1.0	1.5 ± 1.3	0.000
3 months postoperative	2.4 ± 2.7	2 ± 2.1	0.9 ± 1.4	0.014
1 year postoperative	3.0 ± 2.8	2.5 ± 2.5	1.8 ± 2.6	0.085
Leg numbness				
Preoperative	7.2 ± 2.8	5.9 ± 2.1	4.0 ± 2.8	0.000
3 months postoperative	3.2 ± 3.0	2.9 ± 2.6	1.6 ± 1.9	0.035
1 year postoperative	3.5 ± 3.1	3.1 ± 2.9	2.2 ± 2.7	0.099
NRS20				
Preoperative	16.3 ± 1.8	12.2 ± 1.7	7.5 ± 1.8	0.000
3 months postoperative	4.6 ± 4.2	4.2 ± 3.6	2.4 ± 2.3	0.035
1 year postoperative	5.9 ± 4.6	5.0 ± 4.3	4.6 ± 5.2	0.301

By one-way analysis of variance

NRS numerical rating scale, *M* male, *F* female, *BMI* body mass index, *LBP* low back pain

Table 3 Scores on five subscales of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) of each group

Subdomain	Group A	Group B	Group C	*P* value
Pain-related disorders				
Preoperative	31.0 ± 26.6	37.3 ± 31.4	41.0 ± 30.6	0.248
3 months postoperative	68.0 ± 29.2	72.2 ± 29.0	84.0 ± 26.0	0.030
1 year postoperative	66.6 ± 29.7	68.8 ± 31.6	69.7 ± 33.1	0.76
Efficacy rate (%)	70.6	64.7	72.7	0.735
Lumbar spine dysfunction				
Preoperative	48.8 ± 28.5	53.4 ± 28.8	63.6 ± 23.7	0.055
3 months postoperative	61.0 ± 26.1	62.6 ± 24.6	65.2 ± 22.2	0.765
1 year postoperative	64.2 ± 26.7	68.4 ± 25.1	74.2 ± 22.8	0.204
Efficacy rate (%)	45.3	50.6	41.7	0.659
Walking ability				
Preoperative	20.8 ± 21.2	29.0 ± 20.7	36.2 ± 26.3	0.001
3 months postoperative	50.0 ± 30.0	50 ± 20.7	61.1 ± 27.9	0.196
1 year postoperative	53.7 ± 30.9	54.4 ± 32.2	59.7 ± 32.1	0.683
Efficacy rate (%)	66.1	61.4	54.2	0.544
Social life dysfunction				
Preoperative	32.5 ± 18.6	38.0 ± 18.2	39.8 ± 12.8	0.022
3 months postoperative	48.7 ± 21.1	51.6 ± 20.2	52.3 ± 19.6	0.303
1 year postoperative	54.7 ± 20.3	55.1 ± 21.5	57.4 ± 18.1	0.851
Efficacy rate (%)	54.1	40.9	40.0	0.228
Psychological disorders				
Preoperative	42.1 ± 16.3	46.9 ± 13.4	48.8 ± 11.8	0.037
3 months postoperative	55.1 ± 17.5	57.2 ± 14.5	58 ± 13.9	0.548
1 year postoperative	53.2 ± 16.0	53.7 ± 15.3	57.2 ± 12.1	0.514
Efficacy rate (%)	26.6	14.8	20.0	0.204

By one-way analysis of variance

Many studies have investigated the predictors of outcomes after lumbar decompression surgery [3, 11], but the relationship between the symptoms of the patients and the postoperative outcomes remains unclear. Regardless of this lack of evidence, surgeons have recently tended to perform fusion surgery combined with decompression when the patient has significant LBP [4]. A multiple logistic regression analysis by Kleinstück et al. [3] demonstrated that more severe LBP compared with leg pain was related to worse outcomes at 12 months after decompression surgery. However, in the present study, 62% of the patients without leg pain reported that LBP improved after decompression, which indicated that the patients with substantial LBP did not need fusion surgery to achieve relief. Jones et al. [6] showed that decompression decreased by about 50% the number of the patients with an LBP score of 5–10. Crawford et al. [5] reported that 726 patients with substantial LBP improved after decompression surgery without fusion. This is consistent with the results of the present study, which indicated that decompression without fusion relieved the pain of patients with intolerable LBP. Although some studies have reported that the level of leg pain relative to LBP is a significant determinant of the postoperative outcome of decompression [3, 11], the present study indicated that there was no significant difference in the efficacy of decompression depending on the degree of preoperative leg pain. This result shows that decompression without fusion could decrease LBP even if the patients did not suffer from significant leg pain.

There are several possible explanations for our results. First, the surgical procedure for spinal decompression may

Table 4 Radiographic parameters of all patients

Variable	Preoperative	3 months postoperative	*P* value	1 year postoperative	*P* value
LL	37.7 ± 12.9	38.7 ± 13.7	0.070	38.8 ± 13.6	0.052
Scoliosis	5.8 ± 5.2	6.1 ± 5.9	0.119	6.7 ± 5.7	0.000
ROM	28.1 ± 12.2	26.3 ± 11.0	0.017	27.5 ± 11.4	0.473

By paired Student's *t* test

LL lumbar lordosis, *ROM* range of motion

Table 5 Radiographic parameters of each group

Variable	Group A	Group B	Group C	*P* value
LL				
Preoperative	36.9 ± 11.8	39.1 ± 13.8	36.0 ± 14.1	0.312
3 months postoperative	38.2 ± 12.6	39.5 ± 15.1	37.6 ± 13.1	0.682
1 year postoperative	39.4 ± 13.0	38.4 ± 14.5	37.1 ± 12.8	0.864
Scoliosis				
Preoperative	5.5 ± 5.0	6.3 ± 5.7	5.7 ± 3.1	0.248
3 months postoperative	5.8 ± 5.8	6.9 ± 6.4	5.0 ± 3.9	0.203
1 year postoperative	6.2 ± 5.8	7.2 ± 6.0	6.5 ± 4.2	0.218
ROM				
Preoperative	26.7 ± 12.4	28.8 ± 12.2	31.3 ± 10.1	0.14
3 months postoperative	25.6 ± 11.8	26.6 ± 10.4	28.2 ± 9.4	0.413
1 year postoperative	27.0 ± 12.3	28.1 ± 10.7	27.9 ± 10.1	0.608

By one-way analysis of variance

LL lumbar lordosis, *ROM* range of motion

resect the branch of the posterior primary ramus that innervates the facet joints. Lumbar facet denervation has been reported to be an effective treatment for chronic LBP [12]. Second, postural improvement after decompression surgery may relieve LBP [13]. Trunk flexion increases the activity of the paravertebral muscles, thereby causing LBP. Goto et al. showed that decompression surgery improved trunk posture and decreased the activity of the paravertebral muscles [14]. Third, nerve root compression could be associated with LBP, so decompression surgery may improve LBP by nerve root decompression [11].

Several limitations of this study should be acknowledged. First, the postoperative follow-up time was only 1 year. We found that the degree of LBP was slightly worse at 1 year than at 3 months, so it might worsen further with a longer follow-up time. Although some studies have recommended a minimum follow-up of 2 years [15], Staartjes et al. [16] showed that 1 year of follow-up may be sufficient to evaluate patient-reported postoperative outcomes of spine surgery. Furthermore, if the follow-up is longer than 1 year, factors unrelated to decompression surgery may possibly influence the outcome. Second, this study did not evaluate global spinal alignment. Global spinal alignment is associated with LBP and leg pain [17], but we found that although lumbar lordosis tended to increase after decompression surgery, this was not significant. Hikata et al. showed that decompression surgery had some effect on global sagittal alignment [13]. Hence, we assumed that decompression surgery might affect global spinal alignment. Third, the intra-observer reliability for measurements of radiological parameters was not performed, so the accuracy of the measurements could influence the results. Fourth, the number of the patients with mild leg pain was relatively small. The difference of number among groups could change the comparative results. Despite these limitations, this study demonstrated that decompression surgery without fusion could provide relief for patients with substantial low back pain irrespective of the degree of concomitant leg pain. This may be important information when considering whether to perform fusion in addition to decompression surgery.

Conclusion

The present study showed that decompression surgery without fusion could improve the pain of patients with substantial LBP regardless of their degree of leg pain. Decompression surgery alone could relieve LBP in addition to leg pain in appropriate patients with LSS. However, the average score for LBP and leg pain slightly worsened between 3 months and 1 year after surgery.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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