Revision Surgery for Short Segment Fusion Influences Postoperative Low Back Pain and Lower Extremity Pain: A Retrospective Single-Center Study of Patient-Based Evaluation

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Abstract:

Introduction: Patients treated with revision surgery after lumbar decompression with fusion typically have persistent low back pain and lower extremity numbness compared with patients treated with only primary surgery. No well-designed study has investigated the persistence and degree of pain after revision surgery following instrumented operation. The purpose of this study is to compare residual pain among patients who underwent reoperation and those who underwent only primary surgery for lumbar degenerative disorder using patient-based evaluation.

Methods: We reviewed 350 consecutive patients (143 men, 207 women, mean age 63 years) treated with primary lumbar instrumented surgery between October 2010 and February 2014 at our institution and followed up for ≥2 years postoperatively. Patients were categorized into three groups based on number of levels fused: 1-segment, 2-segment, and ≥3-segment fusion (1F, 2F, and ≥3F groups, respectively). We used the Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) and visual analog scales (VASs) for low back pain and lower extremity pain to evaluate pain intensity pre- and postoperatively.

Results: Salvage surgery for late-phase complications was required in 5 cases (2.4%), 6 cases (11.3%), and 11 cases (12.1%) in the 1F, 2F, and ≥3F groups, respectively. In the 1F and 2F groups, patients treated with revision surgery had unsatisfactory improvement in the pain domain of JOABPEQ and VASs for low back pain and lower extremity pain compared with patients with only primary short fusion surgery. The ≥3F group showed no significant differences between patients who underwent reoperation and those who underwent only primary surgery.

Conclusion: Low back pain and lower extremity pain often persist after revision surgery in patients treated with short fusion (≤2-segment) operation. We need to follow pain states in such patients.

Keywords:

lumbar spinal fusion, reoperation, adjacent segment disease, pain

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Introduction

Lumbar spinal canal stenosis (LSCS) due to degenerative changes in the spinal structure is a common debilitating condition which often affects patients' quality of life (QOL)[1]. An increasing number of patients with LSCS also has an accompanying deformity. Conservative treatment is initially preferred but decompression surgery is sometimes required in such patients[2]. Surgical management involving laminectomy combined with fusion has been recommended for LSCS with deformities such as scoliosis or spondylolisthesis[3]. Various studies have demonstrated postoperative complications including implant failure, surgical site infection, non-union at the grafted segment, and adjacent segment degeneration, even though surgical treatment is optimal for these patients[4,5]. However, few studies have reported on the rate of revision for fusion surgery[6,7].

Recurrence of symptoms after an initial period of symptomatic relief can be caused by the progression of degenerative changes at the segment adjacent to the level operated. In patients treated with revision surgery after herniotomy, low back pain and lower extremity pain are more likely to per-

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Table 1. Reoperation Rate of Three Groups and Indications.

	1F group (n=206)		2F group (n=53)		≥3F group (n=91)	
Age (years)	69.6±9.6		70.4±8.8		66.4±15.0	
Sex (Male, %)	47.6%		49.1%		44.0%	
No. of patients treated with reoperation for late-phase complications	5 (2.4%)		6 (11.3%)		11 (12.1%)	
Indication for reoperation and number of cases	ASD	3	ASD	6	ASD	7
	PS loosening	1			Rod breaking	2
	Infection	1			PS loosening	1
					Infection	1
Revision surgery	Two-segment fusion		Decompression alone	1	Long fusion (Th-Pelvis)	10
	Floating fusion	3	Screw replacement	1	Rod replacement	1
	Non-floating fusion	0	Three-segment fusion			
	Long fusion (Th-Pelvis)	1	Floating fusion	1		
	Irrigation	1	Non-floating fusion	3		

Data are expressed as mean±standard deviation. 1F, 1-segment fusion; 2F, 2-segment fusion; ≥3F, ≥3-segment fusion; ASD: adjacent segment disease; PS, pedicle screw

sist compared with patients treated with primary surgery alone[8]. However, no well-designed study has investigated the persistence and degree of pain after revision surgery following instrumented surgery. This study sought to compare patients who underwent reoperation with those who underwent only primary surgery for lumbar degenerative disorder in terms of residual pain using patient-based evaluation.

Materials and Methods

Patients

We evaluated 350 consecutive patients (143 men, 207 women, mean age 63 years) who underwent primary lumbar instrumented surgery for treatment of radiculopathy and/or cauda equina caused by LSCS or lumbar deformity between October 2010 and February 2014 at our institution and were followed up for at least 2 years postoperatively. The study was conducted with the approval of the Ethics Committee of our institution (#1839). Patients were categorized into three groups according to the number of levels fused: 1-segment fusion, 1F group; 2-segment fusion, 2F group; and ≥3-segment fusion, ≥3F group.

Evaluation

Physical data and revision surgery rate

Age and sex were documented to evaluate patients' background preoperatively. The Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ)[9] and visual analog scales (VASs) for low back pain and lower extremity pain were used to evaluate pain intensity pre- and postoperatively. The rate of reoperation and the cause of recurrence were investigated in each group.

Comparison of postoperative pain intensity

To investigate the differences in postoperative pain between patients who underwent revision surgery and patients who underwent only primary surgery, we recruited patients treated with only primary operation (P subgroup) who were matched to patients treated with revision surgery (R subgroup) according to age, sex, surgical method, and number of segments operated, based on propensity score matching. Both groups were compared in each segment category.

Statistical analysis

The paired *t* test was used for statistical analysis between the P and R subgroups. Mann-Whitney U test was performed to compare in terms of VASs. Propensity score matching was performed using IBM SPSS Statistics Version 22 (SPSS, Inc, IL). A p value of <0.05 was considered statistically significant.

Results

Clinical characteristics

Mean follow-up period was 2.9 years and details are summarized in Table 1. There were 206 cases in the 1F group, 53 cases in the 2F group, and 91 patients in the ≥3F group. All cases could complete 2-year follow up (follow-up rate 100%). Salvage surgery for late-phase complications was required in 5 cases (2.4%) in the 1F group, 6 cases (11.3%) in the 2F group, and 11 cases (12.1%) in the ≥3F group. Indications for reoperation were adjacent segment disorder (ASD) in 16 cases, instrumentation failure in 4 cases, and late-phase infection in 2 cases (Table 1). In the 1F group, the revision surgery performed was 2-segment fusion for 3 cases, long fusion for 1 patient, and irrigation for 1 case with infection. Salvage surgery was decompression alone for 1 case, screw replacement for 1 case with screw loosening, and 3-segment fusion for 4 cases in the 2F group, and long fusion for 10 patients and rod replacement for 1 case in the ≥3F group.

Table 2. Patient Demographics and Postoperative Outcomes after Propensity Score Matching.

	1F group		2F group		≥3F group	
	P	R	P	R	P	R
No. of patients	4	4	6	6	11	11
Age (years)	71.3±6.0	70.0±3.6	69.8±4.0	72.8±8.6	71.0±8.3	69.9±10.3
Estimated blood loss (mL)	225±123.3	224.5±130.8	531.8±216.3	584.7±219.5	1256±867	1098±789
Duration of operation (min)	220.0±21.1	210.0±20.5	265.5±54.4	280.2±36.5	397.2±154.2	410.5±149.2
Preoperative pain domain on the JOABPEQ	28.3±37.6	50.0±44.3	19.0±21.9	47.7±43.0	68.0±37.4	57.0±36.9
Preoperative VAS						
Low back pain	61.7±13.5	62.5±28.8	71.0±27.6	59.5±19.2	59.5±17.5	57.0±36.9
Lower extremity pain	76.7±29.1	60.0±24.5	79.3±17.9	67.3±19.8	48.0±34.7	51.2±42.9
Lower extremity numbness	82.7±30.0	55.5±30.6	50.3±34.1	44.6±32.8	65.1±37.5	49.0±34.2
Postoperative Pain domain on the JOABPEQ	100±0*	21.5±24.8	71.0±0*	31.2±36.8	78.5±27.3	66.7±28.0
Postoperative VAS						
Low back pain	3.7±13.5*	55.0±40.1	28.3±6.7*	48.6±27.7	18.3±25.5	23.3±25.5
Lower extremity pain	0±0*	74.3±17.1	27.7±14.7*	57.6±30.9	11.0±14.3	37.7±37.4
Lower extremity numbness	35.7±27.6	48.3±44.4	19.8±39.5	20.3±23.7	20.6±24.0	27.3±30.1

Data are expressed as mean±standard deviation. *P<0.05. 1F, 1-segment fusion; 2F, 2-segment fusion; ≥3F, ≥3-segment fusion; JOABPEQ, ASD: adjacent segment disease; Japanese Orthopedic Association Back Pain Evaluation Questionnaire; PS, pedicle screw; VAS, visual analog scale

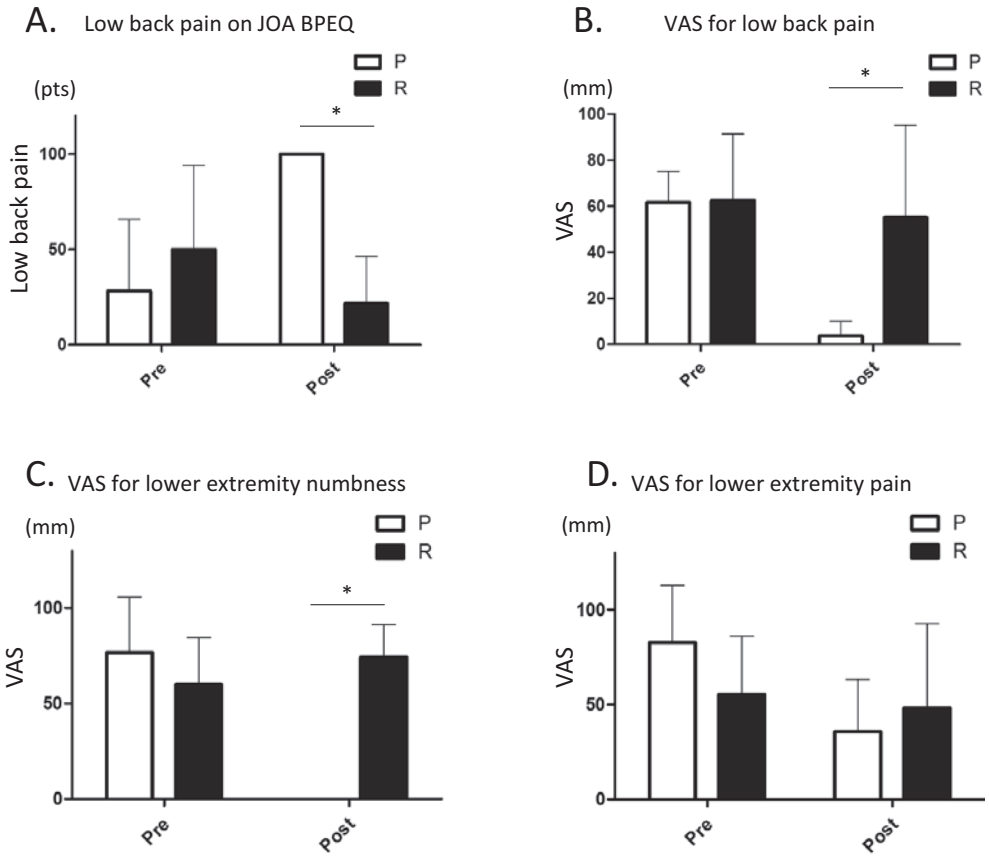

Figure 1. Patient-based pain scores in the 1F group. Low back pain on the JOABPEQ (A), VAS for low back pain (B), VAS for lower extremity numbness (C), and VAS for lower extremity pain (D).

One-year outcomes

The outcomes are as summarized in Table 2. Mean age was 71.3 (P subgroup) and 70.0 (R subgroup) years in the 1 F group, 69.8 (P subgroup) and 72.8 (R subgroup) years in the 2F group, and 71.0 (P subgroup) and 69.9 years (R subgroup) in the ≥3F group. There were no significant differences between the P and R subgroups in estimated blood loss, duration of surgery, and preoperative pain scores including the pain domain on the JOABPEQ and VAS for

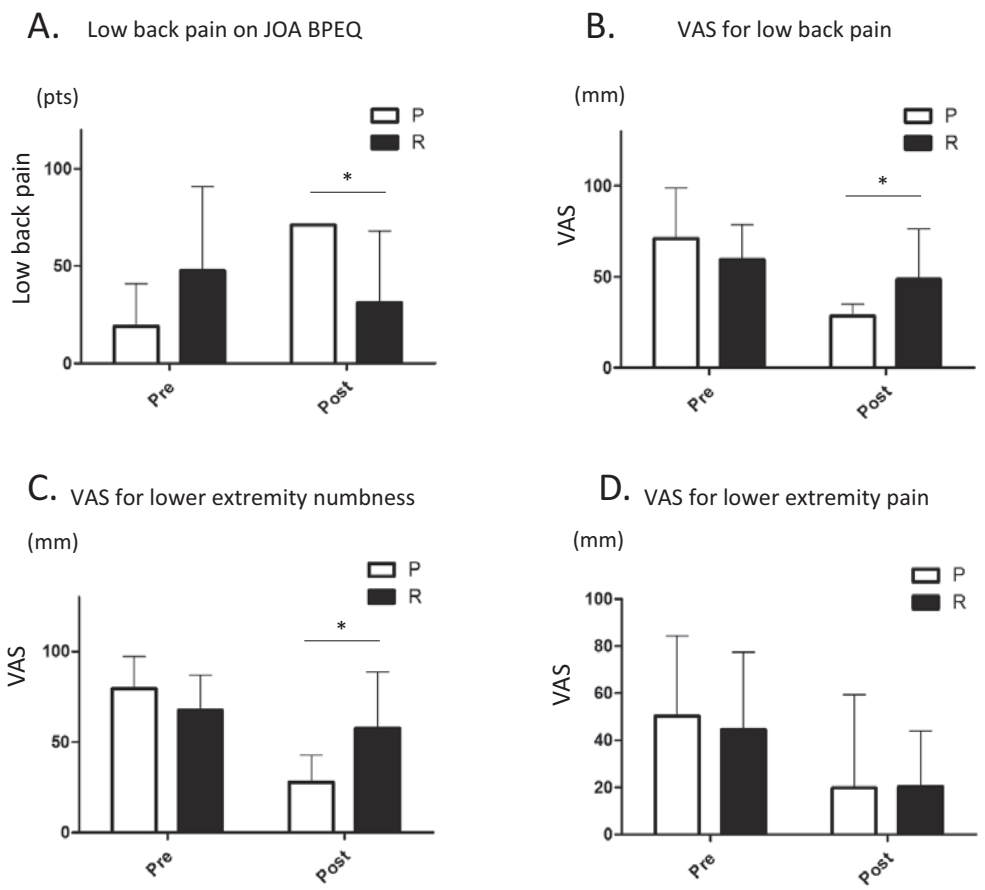

Figure 2. Patient-based pain scores in the 2F group. Low back pain on the JOABPEQ (A), VAS for low back pain (B), VAS for lower extremity numbness (C), and VAS for lower extremity pain (D).

each part. Interestingly, the P subgroups in the 1F and 2F groups showed better improvement in terms of the pain domain of the JOABPEQ and VASs for low back pain and lower extremity pain than R subgroups in both groups; however, there was no difference in VAS for lower extremity numbness between both subgroups in the 1F and 2F groups (Fig. 1, 2). In the ≥3F group, there were no significant differences in postoperative pain evaluation between the P and R subgroups, whereas both subgroups achieved satisfactory improvement (Fig. 3).

Discussion

With population aging in advanced countries, problems due to various degenerative diseases are increasing. Degenerative changes in the lumbar spine often lead to low back pain that can substantially impact QOL. Instrumentation is being increasingly used as an effective method to stabilize the spine in patients with LSCS. However, it is also known that reoperation is sometimes required for some patients who undergo spinal surgery for treatment of LSCS. Lee et al.[10] reported that among 10% of patients who underwent additional surgery within 10 years after lumbar spinal fusion of ≤3 segments, the major cause of reoperation was the development of ASD. Similarly, Brodke et al.[6] demonstrated that reoperation within 2 years after operation was noted in patients treated with spinal fusion surgery. In the present study, 16 (72.3%) of 22 patients underwent reoperation for ASD. As previously reported[11], ASD more frequently occurs in the upper segment of the spine following screw-fixation. Therefore, attention should be paid to preserve the muscle and joint capsule around the upper adjacent facet joint in fusion surgery.

Numerous studies have reported the efficacy of revision surgery for recurrent lumbar stenosis and secondary imbalance. Mendenhall et al.[12] demonstrated that adequate revision surgery enables significant improvement in almost all patient-based score parameters. Successful intervention often achieves pain relief and improved physical activity as well as mental health[13]. Overall, patients who underwent revision surgery had satisfactory outcomes in our study, though the degree of pain relief was significantly lower after revision surgery after primary surgery alone. Compared with previous reports, the unsatisfactory results after revision surgery may theoretically be due to differences in pathology, patient characteristics, or operative technique.

Corrective spinal surgery has been widely applied in patients with progressive thoracolumbar spinal deformity[14]. Studies have shown the potential of long fusion surgery for adult deformity to improve pain and overall health-related

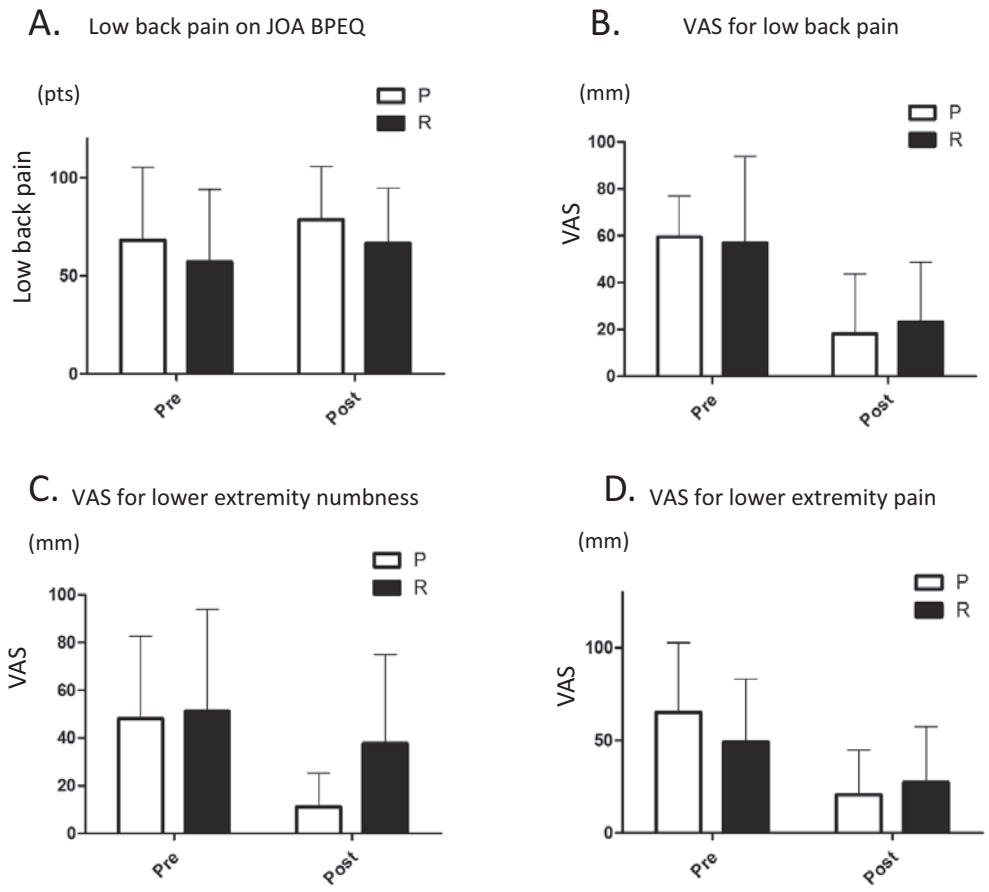

Figure 3. Patient-based pain scores in the ≥3F group. Low back pain on the JOABPEQ (A), VAS for low back pain (B), VAS for lower extremity numbness (C), and VAS for lower extremity pain (D).

QOL. Kondo et al.[15] demonstrated that corrective long fusion significantly yields substantive relief of back pain and improves gait. The present study also demonstrated satisfactory outcomes even in patients who underwent revision surgery for long fusion surgery to the ilium, whereas those who underwent reoperation developed refractory pain in the 1F and 2F groups. This suggests that after short-segment fusion, degeneration might progress in the remaining adjacent segments, often leading to low back pain. As seen in the ≥3F group, rigid fixation and correct spinal alignment can probably reduce back pain even after revision surgery.

We first hypothesized that floating revision fusion surgery influenced unsatisfactory pain domains compared with patients treated with lumbosacral fusion surgery. We could not find that floating revision fusion surgery was associated with residual pain intensity while we calculated multivariate regression model (data not shown). Bydon et al.[16] demonstrated that patients with floating fusion were more likely to develop adjacent segment disease than those treated with non-floating fusion. Further good-quality investigation will be required in future to clarify whether floating fusion correlates with postoperative residual pain.

This study has several limitations. First is possible bias due to selecting the operation methods before surgery and then comparing the three groups. Second is the relatively short follow-up period. Nevertheless, this study is the first report to show differences in residual postoperative pain between patients who underwent reoperation and those who did not. Despite the limitations, we believe that our findings are clinically relevant and provide useful information.

In conclusion, low back pain and lower extremity pain often persist after revision surgery in patients treated with short fusion (≤2-segment) operation. Spine surgeons need to track such patients to provide adequate treatments for pain relief.

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

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Yamada Tsuyoshi: data acquisition, data analysis

Yuasa Masato: data analysis (Log. Regression), interpretation of the data

Ushio Shuta: data acquisition, data analysis

Egawa Satoru: data acquisition, interpretation of the data

Hirai Keigo: data acquisition, data reanalysis

Okawa Atsushi: study design, data acquisition, interpretation of the data, critical revision of the manuscript

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