Outcomes of Decompression with Multi-Segment Long Instrumented Fusion in Lumbar Degenerative Disease

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ABSTRACT

Objective: To evaluate the results of DLF in MDLS performed by a single experienced spine surgeon for both radiographic and clinical outcomes.

Materials and Methods: The database of single-institution was retrospectively reviewed. To identify MDLS patients who had undergone DLF (> 2 levels) between 2007 and 2017. Clinical presentation, radiographic measurements, perioperative complications, and postoperative results were analyzed. The Oswestry disability index (ODI) and EuroQol five dimensions' questionnaire (EQ-5D-5L) were used to evaluate the outcomes comparing the preoperative and the most recent postoperative results.

Results: In total, 84 patients (23 males and 61 females) were enrolled, with an average age of 64.4±8.6 (46-81) years old. Among these, 39 patients had fusion to L5 and 45 patients had fusion to the sacrum. Mean operative time was 66.9+23.4 minutes per level (range: 22.2-140) and the average length of stay was 10.7+5.7 days (range: 5-39). The mean estimated blood loss was 290.6+168.5 ml (range: 21.4-666.7). Average follow-up was 50.0+29.8 months (range: 0.5-124). The average preoperative ODI score was 60.6+16.3 (28-97.8) and 24.2+17.3 (0-71.1) postoperatively, while the average preoperative and postoperative EQ-5D-5L scores were 0.161+0.268 and 0.818+0.225, respectively. Both these clinical scores (ODI and EQ-5D-5L) showed a statistically significant improvement ($p < 0.001$). Finally, 13% (11/84) of patients had further surgery.

Conclusion: Decompressive laminectomy and long spinal fusion performed in patients with multi-level deteriorating lumbar spinal stenosis are safe and effective in terms of the patients' quality of life and disability improvement.

Keywords: Lumbar spinal stenosis; multi-level fusion; quality of life; disability; Oswestry disability index (Siriraj Med J 2022; 74: 548-554)

INTRODUCTION

Degenerative disease of the lumbosacral spine can result in back pain, neurogenic claudication due to spinal stenosis, and deformity (both in the coronal and sagittal plane). Surgical treatment for this problem usually consists of a posterior spinal fusion, decompression, and correcting the deformity.[1,2] Long fusion (more than 2 levels) is contemplated for more extensive cases, such as a posterior spinal fusion from L2 to L5 to the sacrum. In patients with deformity, either scoliosis or flat back, an extended fusion up to the thoracic spine or the S2 iliac is required. The surgery is considered quite extensive because of the long operating time, blood loss, and high complication rate.

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Received 23 June 2021 Revised 9 February 2022 Accepted 27 March 2022
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http://dx.doi.org/10.33192/Smj.2022.65

This study aimed to evaluate the results of such procedures performed by a single experienced spine surgeon, in terms of both the radiographic and clinical outcomes.

MATERIALS AND METHODS

This study was first obtained by the Siriraj Institutional Review Board approval (Si 031/2012). The study involved a retrospective review of the medical records in the institutional database covering the period between February 2007 to August 2017. The inclusion criteria were patients with the lumbar degenerative disease with spinal stenosis who had undergone long posterior spinal fusion (more than 2 levels) with titanium pedicle screw and rod (Orthipesia®).

Data collection

The data collected were related to the patients' demographic data, including gender, age at surgery, comorbidities, procedure information, implant type, estimated blood loss (EBL), postoperative complications, hospital length of stay (LOS), neurological outcomes, reoperation, time of operation, intraoperative complications, graft type, radiographic findings, and mortality. Radiographic assessments using lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), and Cobb angle. The Oswestry disability index (ODI)[3] and EuroQol-5 Dimensions Questionnaire (EQ-5D-5)[4] were designed to evaluate the outcomes by comparing preoperative and most current postoperative results to assess the outcomes. The frequencies for categorical and ordinal variables, as well as the averages, standard deviations, and ranges for quantitative data, were determined using descriptive statistics. For continuous variables, the Mann–Whitney U-test was used, and for categorical variables, the Chi-square test was used. For *p*-values of <0.05, statistical significance was assumed, and odds ratios were calculated with the interval of 95 % confidence.

Surgical procedure

In a typical procedure, the patients were situated in a prone post. The paraspinal muscles were then dissected using a midline incision. Pedicular screws were placed on both sides, and decompressive laminectomy was accomplished. Posterolateral fusion was achieved using a local or iliac crest autograft. The operative surgeon determined the number of decompressive levels and fusion levels.

RESULTS

In total, 84 patients were included in this study, comprising 23 males and 61 females. The average age of patients was 64.4±8.6 years old (range: 46–81) and the average BMI was 26.5±4.1 (range: 15.5–37.2). The mean operative time was 66.9±23.4 minutes per level (range: 22.2–140) and the average length of stay was 10.7±5.7 days (range: 5–39). The mean estimated blood loss was 290.6±168.5 ml (range: 21.4–666.7). The average follow-up was 50.0+29.8 months (range: 0.5–124). The average number of fused levels was 4.46+1.85 (ranges 3–9). There were 37, 20, 7, 4, 7, 5, and 4 patients who had fusion involving 3, 4, 5, 6, 7, 8, and 9 levels, respectively, while 39 patients had fusion to L5 and 45 patients had fusion to the sacrum. The patients' demographic data are summarized in Table 1.

The average preoperative LL, PI, PT, and SS were 28.98 ± 17.31(-11–81), 51.98 ± 11.41 (30–76), 27.57 ± 9.36 (3–58), and 24.39 ± 10.24 (-8–49), respectively. The average postoperative LL, PI, PT, and SS were 33.75 ± 13.7 (2–60), 52.49 ± 11.02 (30–77), 25.16 ± 8.05 (0–42), and 27.22 ± 8.44 (5–46), respectively. There were significant differences in LL, PT, SS, and Cobb angle (Table 2). When comparing between patients who were fused at L5 and to the sacrum, there were no significant differences in all parameters. The data are shown in Table 3. In patients with degenerative scoliosis (Cobb's angle of more than 10 degrees), the average Cobb's angle was improved from 23.47 ± 11.20 to 15.11 ± 10.14 degrees.

In terms of clinical outcomes, both the ODI and EQ-5D-5L scores showed a statistically significant improvement ($p < 0.001$). The average preoperative ODI score was 60.6±16.3 (28–97.8) and 24.2±17.3 (0–71.1) postoperatively. The average preoperative and postoperative EQ-5D-5L

TABLE 1. Demographic data of the patients.

Data	Average
Age (year)	64.4 ± 8.6 (46, 81)
BMI (kg/m^2)	26.5 ± 4.1 (15.5, 37.2)
Operative time (minute)	66.9 ± 23.4 (22.2,140)
Length of stay (day)	10.7 ± 5.7 (5, 39)
Estimated blood loss (ml)	290.6 ± 168.5 (21.4, 666.7)
Number of fused levels (level)	4.46+1.85 (3–9)
Follow-up (month)	50 ± 29.8 (0.5, 124)

TABLE 2. Preoperative and postoperative radiographic measurements.

Parameter	Mean Preoperative (degree)	Mean Postoperative (degree)	p-value
LL	28.98 ± 17.31 (-11,81)	33.75 ± 13.7 (2,60)	0.002
PI	51.98 ± 11.41 (30,76)	52.49 ± 11.02 (30,77)	0.410
PT	27.57 ± 9.36 (3,58)	25.16 ± 8.05 (0,42)	0.002
SS	24.39 ± 10.24 (-8,49)	27.22 ± 8.44 (5,46)	0.001
Cobb	15.71 ± 11.95 (1,63)	10.75 ± 9.25 (0,47)	0.000

TABLE 3. Radiographic measurements and outcomes comparing fusion to L5 and fusion to the sacrum.

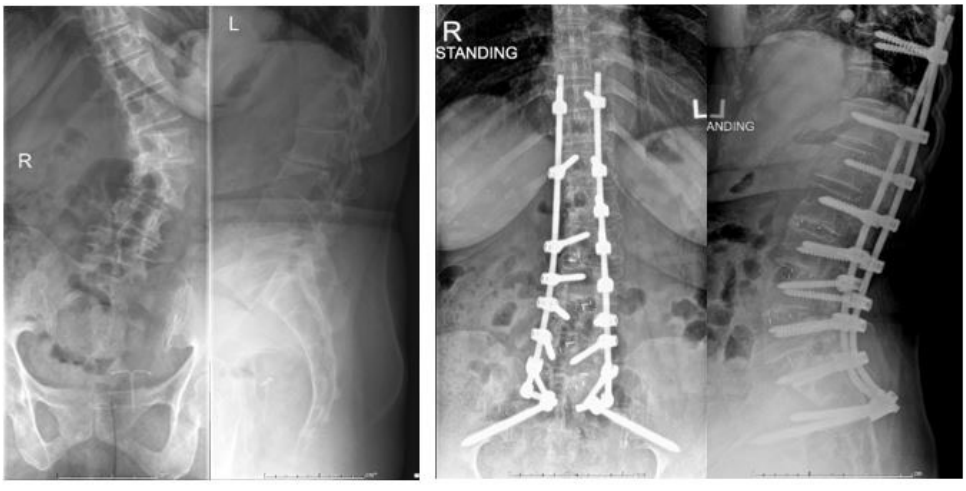
Clinical Measurement	Mean preoperative (degree)	Mean postoperation (degree)	Within group p-value	Between groups p-value
LL				
Fusion to L5 (n = 19)	29.36 ± 19.33	33.21 ± 13.56	0.557	0.962
Fusion to the sacrum (n = 31)	28.64 ± 15.51	34.23 ± 13.97		
PI				
Fusion to L5 (n = 19)	53.28 ± 11.40	53.28 ± 9.97	0.439	0.411
Fusion to the sacrum (n = 31)	50.82 ±11.42	51.80 ± 11.96		
PT				
Fusion to L5 (n = 19)	29.18 ± 10	26.56 ± 7.84	0.797	0.108
Fusion to the sacrum (n = 31)	26.14 ± 8.63	23.91 ± 8.11		
SS				
Fusion to L5 (n = 19)	24.26 ± 8.40	26.72 ± 7.55	0.660	0.758
Fusion to the sacrum (n = 31)	24.50 ± 11.73	27.66 ± 9.21		
Cobb				
Fusion to L5 (n = 19)	15.56 ± 9.45	10.69 ± 6.73	0.916	0.932
Fusion to the sacrum (n = 31)	15.84 ± 13.91	10.80 ± 11.10		
ODI				
Fusion to L5 (n = 19)	60.4 15.7	24.9 17.9	<0.001	0.840
Fusion to the sacrum (n = 31)	60.7 17.0	23.7 17.2	<0.001	
EQ-5D-5L				
Fusion to L5 (n = 19)	0.114 0.236	0.799 0.221	<0.001	0.712
Fusion to the sacrum (n = 31)	0.189 0.285	0.831 0.231	<0.001	

Abbreviations: LL; Lumbar lordosis, PI; Pelvis index, PT; Pelvis tilt, SS; Sacral slope, Cobb; Cobb's angle
ODI; Oswestry Disability Index, EQ-5D-5L; EUROQOL 5 Dimensions 5 Levels

scores were 0.161+0.268 and 0.818+0.225, respectively. The outcomes for patients who had scoliosis before the surgery also improved postoperatively for both scores (ODI from 64.32 ± 15.02 to 23.45 ± 16.78 and EQ-5D-5L from 0.179 ± 0.313 to 0.828 ± 0.221). Additionally, significant clinical improvements were found in both the L5 and sacral fusion groups.

There were cases of 8 dura tears (9.5%). Three patients needed a revision of the pedicle screw due to breaching of the pedicle causing radicular pain. Two patients developed hematoma postoperatively, which required surgical removal at postop days 3 and 5, respectively. Also, massive bleeding due to a segmental artery tear occurred in one patient; while one patient developed a transient ischemic attack; one had superficial wound infection, which required a debridement; one patient had acute cholecystitis; one patient developed left common iliac vein thrombosis; one patient required exploration of the nerve root and removal of the pedicle screw at the L4–5 level, and one patient developed pneumonia postoperatively.

Overall, 11 out of the 84 patients (13.1%) needed further surgery. Three of the 39 patients who had fusion to L5 had extended fusion through the L5–S1 level at 4, 12, and 30 months, respectively, due to a further symptomatic degenerative change in the L5–S1 level. Four of the 45 patients who had fusion through the L5–S1 disc had a revision of the L5–S1 level at 3, 5, 10, and 12 months, respectively, due to displacement of the PEEK in two patients and loosening of the S1 screw in the two other patients. Overall, three patients (3.57%) had extended fusion proximally at 30, 48, and 114 months, respectively. One patient had a proximal junctional fracture and required extended fusion to T4 at 2 months (Figs 2 & 3).



a b

Fig 1. A 61-year-old female underwent a long fusion. The outcomes and Cobb angle were improved postoperatively (ODI from 86.67 to 17.78, EQ5d5L from -0.089 to 1, and Cobb angle from 48 to 17).

a b

Fig 2. A 57-year-old female underwent long fusion from T10 to L5 due to degenerative adult scoliosis with stenosis (a). She had extended fusion to S1 using rod connectors and PEEK rods at nine and a half years (114 months) after the first surgery (b)

a b

Fig 3. A 72-year-old female underwent long fusion from T10 to S2 due to degenerative adult scoliosis with stenosis (a). She had extended fusion to T4 due to proximal junctional fracture at 2 months (b).

DISCUSSION

Degenerative lumbar spinal stenosis (DLS) is a common disease in the elderly. The prevalence of DLS was reported as 5.7–9.3% in a Japanese population and increased with age.[5,6] In terms of radiographic evaluation, the magnetic resonance image (MRI) of the lumbar spine is the gold standard. Srisajjakul and Chawalparit reported the positive predictive values of multiplanar reconstruction computed tomography (MPR-CT) in assessing the central canal stenosis, lateral canal stenosis, and foraminal stenosis were 77.7%, 75% and 50%, respectively. So, the MPR-CT may be considered as a choice of radiographic assessment in DLS patients who had contraindication for MRI.[7]

The current study showed that decompression with multi-segment long instrumented fusion could significantly improve the sagittal profile and clinical score (both ODI and EQ-5D-5L) compared within the preoperative period. These results were related not only to simple degenerative spinal stenosis but also to degenerative scoliosis. Interestingly, the results for a lower instrumented fusion level (L5 vs. the sacrum) did not show a statistically significant difference. Meanwhile, the complication rate was 23.8% (20/84), but surgical-related complications occurred at 17.85%.

The current study concurred with the results of previous research. However, there is some controversy between limited/long fusion and selective/limited decompression. Sun et al. reported the treatment results from 42 patients, Patients with multi-segment lumbar spinal stenosis and single-segment regressive spondylolisthesis were separated into two groups, comprising 22 patients with selective or 20 with multi-segmental compression and fusion. The results showed all the clinical scores (VAS, ODI, and SF-36) at one-year follow-up and three-year follow-up. Both groups were improved considerably compared with their preoperative scores ($p < 0.01$), but no significant differences between the groups were detected at moment in time. However, the multi-segmental compression and fusion group had a longer operative duration and more blood leak. Also, 15 % of the patients in the multi-segmental compression and fusion group had advanced postoperative instability at the adjacent segments above the fused segments at the 3-year follow-up.[1] Lee et al, performed a systematic meta-analysis comparing short limited fusion versus extended fusion with deformity correction in balanced de novo degenerative scoliosis with lumbar spinal stenosis. Six studies involving 362 patients (divided into two groups: 202 short fusions and 160 long fusion) were included in the analysis and the results showed that both groups had a decreased Cobb angle, C7 plumb, and ODI at the final follow-up. Additionally, the lengthy fusion group had showed a significant reduction in Cobb angle and the C7 plumb. However, the short fusion group had lower blood leak (average difference, 739.9 mL) and a shorter operative time (average difference, 68.0 minutes) compared to the long fusion group. Finally, it was concluded that short fusion may be a reasonable option and have a lower risk of curve progression.[8]

Postoperative constipation is a common problem in spine surgery. Siripohn et al conducted a prospective randomized controlled trial comparing only standard nursing care and standard nursing care combined with Thai traditional medicine of abdominal massage (TTMAM group) in patients who underwent lumbar laminectomy. The TTMAM group had a larger percentage of patients who had their first feces between 3 days of surgery and

had reduced abdominal distension on the third day following surgery. Additionally, the TTMAM group's mean patient satisfaction score was greater.[9]

In the present day, the role of minimally invasive surgery has substantially increased. Fan et al. Compared posterior lumbar interbody fusion (PLIF) clinical results versus minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) in 60 patients who had 3-level degenerative lumbar spinal stenosis. They found no significant variations in back VAS, leg VAS, SF-36, fusion condition, ODI, and difficulties at 12-month follow-up between the two groups ($p > 0.05$). However, the MIS-TLIF group had significantly less blood leak, a shorter hospital stay ($p < 0.05$), and a lower back VAS than those in the PLIF group at 6-month follow-up ($p < 0.05$).[10] Wu et al, showed that a combination of microendoscopic discectomy and minimally invasive transforaminal lumbar interbody fusion in 26 multilevel degenerative lumbar spinal stenosis patients with spondylolisthesis compared with 27 traditional PLIF patients had several advantages, including lower blood loss, less injury to the paraspinal soft tissue, a shorter incision, shorter bed rest time, improved outcomes, and shorter recovery times. However, there were no significant differences between the two groups' operation times or ODI scores.[11] Unfortunately, only open techniques were covered in that study.

Son et al. compared the outcomes between decompression alone versus fusion in elderly patients with two-level or more lumbar spinal stenosis. The results showed that there were no significant differences between the two groups with respect to age, follow-up period, surgical levels, or preoperative condition, though it was found that correction of the lumbar lordosis angle was better in the fusion group at follow-up. However, other clinical outcomes, including VAS, ODI, and Odom's criteria, were not significantly different, but the operation duration. In the decompression-alone group, estimated blood loss and surgical complications were much lower. As a result, the authors concluded that decompressive laminectomy alone was effective in patients with two or more levels of lumbar spinal stenosis who also had a poor general condition or osteoporosis.[12] In Thailand, Keorochana et al. conducted a prospective observational study in 31 degenerative lumbar scoliosis patients with spinal stenosis and reported the effects of decompression and instrumented fusion with a pedicular screw plate system. All of the end indicators, including the pain scales, walking ability, ODI, and Roland Morris score, showed a substantial improvement (p 0.05). Five patients, however, experienced serious problems, with two of them requiring re-operation.[2]

The limitations of the present study include its retrospective nature, a small number of patients, a wide range of follow-up periods, and the use of a single-center database. A large, multi-center, well-controlled study also comparing various fusion techniques could provide additional information about how multi-segment lumbar spinal stenosis is treated in Thailand.

CONCLUSION

This is the first study from Thailand reporting the treatment outcomes of decompression with multi-segment instrumented fusion in lumbar degenerative disease patients. The results showed statistically significant improvements both in the clinical and radiographic results. Additionally, only 13% of patients needed further surgery.

ACKNOWLEDGMENTS

The authors would like to thank Miss Supani Duangkaew for editing the manuscript and assisting in its preparation for journal submission.

What is already known on this topic?

The previous study reported good results from decompressive laminectomy and fusion in terms of pain, disability, and quality of life improvements. The use of minimally invasive surgery, including MIS-TLIF or a microendoscopic discectomy combination, also provided non-inferior results with the benefits of lower bleeding and a shorter length of hospital stay.

What this study adds?

The present study showed that decompressive laminectomy and fusion in multi-level spinal stenosis, including degenerative lumbar scoliosis, improved the patients' radiographic outcomes, quality of life, and disability. Also, a lower instrumented level (L5 vertebra or the sacrum) provided good results. However, surgical-related complications (including dural tear, hardware complication, and hematoma) were not uncommon.

Potential conflicts of interest

The authors confirm they have no potential conflicts of interest relevant to this article to declare.

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