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Outcomes in Combined Anterior and Posterior Fusion for 3- and 4-Level Degenerative Lumbar Disc Disease

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ABSTRACT

Introduction. This study reported the clinical and functional outcomes in a consecutive series of patients with 3- or 4-level degenerative disc disease (DDD) between vertebral levels L2 to S1, who were treated with combined anterior lumbar interbody fusion (ALIF) and posterior spinal fusion at one-year and two-year follow-ups.

Methods. A retrospective chart review was performed on all patients who underwent long segment fusion for DDD by a single surgeon between August 2002 and January 2012. Fifty-five patients were identified and 32 had complete charts for review (14 had one-year follow-up and 18 two-year follow-up). In addition to demographic data, disability (Oswestry Disability Index, ODI), pain level (Visual Analog Scale, VAS), and flexion-extension range-of-motion were measured pre- and post-operatively. Operative data also were collected, including operative time, blood loss, surgical implants used, surgical approach, operative levels treated, and complications.

Results. Both VAS and ODI improved significantly post-operatively. The average VAS score improved from 6.5 ± 1.5 (range: 4 - 9) to 4.4 ± 1.7 (range: 2 - 7) for one-year follow-up, and 7.0 ± 1.8 (range: 4 - 10) to 4.4 ± 2.6 (range: 1 - 9) for two-year follow-up. For one-year follow-up, the average ODI score improved from 53 ± 19% (range: 18 - 70%) to 37 ± 17% (range: 12 - 64%), and for two-year follow-up, the average improved from 53 ± 18% (range: 18 - 80%) to 31 ± 24% (range: 2 - 92%). The level of improvement in pain and function was similar to previously published data for 1- and 2-level fusions, but overall pain and function scores were worse in this study group.

Conclusions. Arthrodesis for 3- and 4-level DDD is, on average, a successful surgery that shows clinically significant improvements in function and pain similar to fusion for 1- and 2-levels with low rates of re-operation. Patients with involvement of 3- or 4-levels have higher disability and pain both pre- and post-operatively compared to shorter fusion level involvement. ***KS J Med 2016;9(3):50-53.***

INTRODUCTION

Degenerative disc disease (DDD) is a common pathologic process that can cause low back pain. A non-operative approach is preferred initially and is often successful, but some patients progress to lumbar stenosis, facet arthrosis, and/or degenerative spondylolisthesis, all of which may be associated with chronic low back pain and/or sciatica (leg pain, numbness, or tingling) and can lead to significant disability.[1,2] Lumbar spinal fusion improves pain and function in patients with DDD who have failed non-operative treatment, but remains controversial as literature is limited and has focused mainly on 1- and 2-level procedures.[2-5] With improvement of surgical approach, fusion techniques, and patient selection, surgical treatment has shown improvement in pain and disability.[2,6] Despite some clinical success, concern remains over complications, cost, adjacent segment disease, and question of improvement over non-operative treatment.[2,6,7] Fusion for 1- and 2-level disease has become a common practice, but longer fusion has been utilized less due to limited evidence and concern of higher complication rate.

Retrospective studies completed in the last decade have produced mixed results on how length of fusion affects outcomes. Lettice et al.[8] in 2005 showed higher pseudarthrosis and re-operation rates, but equal functional scores comparing long to short fusion over two years of follow-up. This group included posterior and 360° approaches. Suratwala et al.[3] in 2008 showed improvement in post-operative functional scores, including 30% improvement in Oswestry Disability Index (ODI), for patients undergoing 360° fusion with either anterior or transforaminal lumbar interbody fusion. However, there was a 20% pseudarthrosis rate, 11% adjacent segment disease, and no control or comparison group. Most recently, Lee et al.[9] in 2011 found patients undergoing three or more level fusions had lower post-operative functional scores but equal pain and satisfaction outcomes compared to short fusions. Their study used posterior approach with interbody fusion. Overall, this literature indicated improvement in pain, function, and disability but inconsistent results compared with short fusion.

The purpose of this study was to report the clinical and functional outcomes of a consecutive series of patients with 3- or 4-level DDD between vertebral levels L2 to S1 who were treated with combined anterior lumbar interbody fusion (ALIF) and posterior spinal fusion at one-year and two-year follow-ups.

METHODS

After Institutional Review Board approval was obtained, a retrospective chart review was performed on all patients who underwent combined anterior and posterior fusion of 3 or 4 vertebral levels for DDD by one surgeon between August 2002 and January 2012. The inclusion criteria included subjects' age between 18 and 75, diagnosis of 3- or 4-level DDD amenable to treatment with fusion, failure of at least three months of non-operative treatment. Exclusion criteria included previous spine fusion, two or fewer degenerative levels, major deformity, previous infection or tumor, or a diagnosis other than DDD, including any one of the following diagnoses: spinal stenosis

requiring decompression, isthmic spondylolisthesis, or degenerative spondylolisthesis greater than three (3) millimeters.

Subjects who underwent fusion and met the above criteria were identified through surgical log. Data were collected retrospectively by chart review and included pre-operative, surgical, functional, and post-operative information collected as part of the routine clinical visit and standard of care at one-year and two-year follow-up. Patients had their disability and pain level measured at pre-operative (baseline) and on follow-up visits using the Visual Analog Scale (VAS) for back pain and ODI (range 0 to 100%) for function. The VAS scores were recorded as numerical values 0 to 10; "0" indicated no back pain and "10" indicated unbearable back pain. Patients were asked to indicate where their current pain level was on the line. The ODI was measured using a 10-section questionnaire (range: 0, normal to 5, impossible) asking the patient to indicate the intensity of their pain and to what degree pain is affecting daily activities such as sitting, walking, and traveling. Responses were scored and reflected the patient's percentage of disability. The measurement of success improvement criteria was based on VAS with at least one unit scale improvement different compared to the baseline (pre-operatively), and on ODI scores of at least 15% difference compared to the baseline.

Pre- and post-operative data included patient's age, sex, height, weight, race, smoking status, diagnoses, prior surgeries, past medical history, flexion-extension range of motion (forward and backward bending), pain score, and ODI. Operative data included operative time, blood loss, surgical implants used, surgical approach, operative levels treated, and complications. Post-operatively, the same patient demographics were recorded, as well as post-operative complications, pain scores, and ODI.

Statistical analysis. All statistical analyses were conducted using SPSS software (Version 19.0; SPSS Inc, Chicago, IL) and the level of significant difference was defined as $p < 0.05$. The values were recorded as the mean with standard deviation. A one-way analysis of variance (ANOVA) was conducted to determine the difference in pre-operative and post-operative clinical and functional outcomes within each study group. Appropriate Independent Samples t-test was used to compare outcomes between study groups. Demographic and pre-operative data also were compared between study groups.

RESULTS

There were a total of 55 patients who met the inclusion criteria; only 32 (15 female and 17 male) had available medical records for evaluation and were included in this study. Of the 32 patients, 14 (44%) had one-year follow-up and 18 (56%) had two-year follow-up. Both groups had similar ages (average: 46 years, range: 28 - 58 years), body mass index (BMI), race (Caucasians mostly), a high percentage with no previous spine surgery (> 80%), and most had 3-level spinal fusion (Table 1). There were no significant differences between the two groups in gender, age, race, tobacco usage at time of surgery, height, weight, BMI, prior surgical treatment, or number of levels fused ($p > 0.05$).

Intra-operative data. The average operative time for 3-level fusion was 273 ± 31 minutes (range: 225 - 345 minutes), while 4-level fusion was 345 ± 46 minutes (range: 300 - 420 minutes). The 4-level fusion took an average of 72 minutes (26%) more than 3-level fusion. Meanwhile, the average estimated blood loss for 3- and 4-level fusion was 224 ± 152 mL (range: 75 - 600 mL) and 580 ± 297 mL (range: 400 - 1100 mL), respectively. The estimated blood loss for 4-level fusion was about 356 mL (159%) more than 3-level fusion.

Flexion-extension range of motion. For patients with one-year follow-up, 7 (50%) of the 14 patients sustained the same flexion-extension range of motion (ROM) compared to their pre-operative ROM, while six patients (43%) improved their ROM (10° ROM: 2, 20° ROM: 3, 40° ROM: 1), and one patient (7%) reduced 30° of flexion-extension ROM. Of the 18 patients with two-year follow-up, nine (50%) sustained the same flexion-extension ROM, while eight (44%) improved their ROM (10° ROM: 1, 20° ROM: 1, 30° ROM: 3, 50° ROM: 1, 60° ROM: 2). Similar to the one-year follow-up group, there was a patient with reduced 30° ROM compared to the pre-operative ROM.

Table 1. Patient demographics.

		1-year follow-up (N=14)	2-year follow-up (N=18)	p-value
Gender	Female	6 (43%)	9 (50%)	0.699
	Male	8 (57%)	9 (50%)	0.699
Age (years, mean ± SD) (range)		46 ± 8 (28 - 58)	45 ± 9 (28 - 58)	0.656
Race	Caucasians	13 (93%)	16 (89%)	0.713
	African-Americans	1 (7%)	1 (6%)	0.860
	Hispanics	0 (0%)	1 (6%)	0.387
Tobacco Usage at Time of Surgery	Never	4 (29%)	7 (39%)	0.557
	Former	2 (14%)	5 (28%)	0.376
	Current	8 (57%)	6 (33%)	0.189
Height (inches, mean ± SD)		68 ± 4	69 ± 4	0.680
Weight (lbs, mean ± SD)		210 ± 40	211 ± 47	0.947
BMI		31.9 ± 4.9	31.4 ± 5.4	0.771
Prior Surgical Treatment	Yes	3 (21%)	2 (11%)	0.442
	No	11 (79%)	16 (89%)	0.442
Number of Levels Fused	3-level	13 (93%)	14 (78%)	0.258
	4-level	1 (7%)	4 (22%)	0.258

VAS pain scores. The average VAS score improved from 6.5 ± 1.5 (range: 4 - 9) pre-operatively to 4.4 ± 1.7 (range: 2 - 7) post-operatively for one-year follow-up, and 7.0 ± 1.8 (range: 4 - 10) pre-operatively to 4.4 ± 2.6

(range: 1 - 9) post-operatively for two-year follow-up. Both groups showed a statistically significant improvement (Table 2). One patient with two-year follow-up showed a significant increase in pain after surgery (pre-operative: 6, post-operative: 9). There was no significant difference detected between the one-year and two-year follow-up in terms of VAS pain scores.

Table 2. Summary results for VAS pain scores and ODI scores.

		Pre-Op	Post-Op	Difference	p-value (pre vs. post)	p-value (1-yr. vs. 2-yr.)
VAS	1 yr. Follow-up	6.5 ± 1.5	4.4 ± 1.7	2.1 ± 1.6	0.00	0.08
	2 yr. Follow-up	7.0 ± 1.8	4.4 ± 2.6	2.6 ± 2.8	0.00	
ODI	1 yr. Follow-up	52.6 ± 18.5%	37.4 ± 16.6%	15.1 ± 18.5%	0.03	0.26
	2 yr. Follow-up	53.0 ± 18.4%	30.8 ± 24.1%	22.2 ± 24.1%	0.00	

Oswestry Disability Index (ODI) scores. For one-year follow-up, the average ODI score improved significantly from 53 ± 19% (p = 0.03; range: 18 - 70%) pre-operatively to 37 ± 17% (range: 12 - 64%) post-operatively (Table 2). However, four patients (29%) remained unchanged, eight patients (57%) improved but only five patients (36%) improved at least 15% compared to baseline, and two patients (14%) worsened (Table 3). For two-year follow-up, the average improved significantly 53 ± 18% (p = 0.002; range: 18 - 80%) pre-operatively to 31 ± 24% (range: 2 - 92%) post-operatively (Table 2). Four patients (22%) remain unchanged, 12 patients (67%) improved but only 10 out of the 12 patients (56%) improved at least 15% compared to baseline, and two patients (11%) worsened (Table 4). There was no significant difference detected between the one-year and two-year follow-up in terms of ODI scores.

Complications. Seven (22%) of 32 patients experienced some complications and no patient experienced intra-operative or major complications such as death or neurological damage. Post-operatively, one patient was re-hospitalized at five months for severe back pain, and this patient had adjacent-level degenerative disease at one-year post-operatively. One patient had a retroperitoneal hematoma found post-operatively that was resolved by six weeks with a drain and had no further complications. One patient had severe bilateral lower extremity pain that improved with non-operative modalities by six months. Four patients had a superficial surgical site infection that was treated with oral antibiotics and all resolved by the six week post-operative appointment.

Table 3. Clinical Oswestry Disability Index (ODI) scores for one-year follow-up.

	Post-Operative ODI Scores					
Pre-op ODI Scores	Minimal Disability (0 - 20%)	Moderate Disability (21 - 40%)	Severe Disability (41 - 60%)	Crippled (61 - 80%)	Bed-ridden (81 - 100%)	Total (Row Sum)
Minimal Disability (0 - 20%)	2	0	0	0	0	2
Moderate Disability (21 - 40%)	0	0	1	0	0	1
Severe Disability (41 - 60%)	0	2	2	1	0	5
Crippled (61 - 80%)	1	3	2	0	0	6
Bed-ridden (81 - 100%)	0	0	0	0	0	0
Total (Column Sum)	3	5	5	1	0	14

Note: = patient worsens; = no change; = patient improves

Table 4. Clinical Oswestry Disability Index (ODI) scores for two-year follow-up.

	Post-Operative ODI Scores					
Pre-op ODI Scores	Minimal Disability (0 - 20%)	Moderate Disability (21 - 40%)	Severe Disability (41 - 60%)	Crippled (61 - 80%)	Bed-ridden (81 - 100%)	Total (Row Sum)
Minimal Disability (0 - 20%)	2	0	0	0	0	2
Moderate Disability (21 - 40%)	0	0	1	0	0	1
Severe Disability (41 - 60%)	3	4	2	0	0	9
Crippled (61 - 80%)	2	2	1	0	1	6
Bed-ridden (81 - 100%)	0	0	0	0	0	0
Total (Column Sum)	7	6	4	0	1	18

Note: = patient worsens; = no change; = patient improves

DISCUSSION

Degeneration of lumbar intervertebral discs can be a debilitating disease, even without spinal stenosis or dominant lower extremity symptoms.[1] Non-operative modalities are the preferred treatment, but when the symptoms are persistent, surgical intervention can be an option.[10,11] For 1- and 2-level disease, arthrodesis with an anterior-only or 360° fusion has been shown to be safe and successful in improving pain and function.[3,4,12] However, studies on longer fusions for DDD have been scarce and the results less predictable.[3,8,9] This study indicates that patients who undergo combined ALIF and posterior spinal fusion for 3- and 4-level DDD have, on average, significant improvement in both function and pain after one and two years post-operative.

Subjects who underwent long fusion did not have an increased frequency of minor complications, such as persistent severe pain, hematoma, or surgical site infection when compared to subjects who underwent short fusion (1- or 2-level fusion).[4,5] However, the pain level improvement for this study was only 2.1 for one-year follow-up and 2.6 for two-year follow-up, which was significantly less than the improvement seen in 1- and 2-level fusions at two-year follow-up (3.3).[4]

Gains in functional outcomes were similar to those undergoing short fusions and similar percentages of patients undergoing long fusion improved or maintained functionality compared with those who had shorter fusions (current study: one-year follow-up: 15% difference, two-year follow-up: 22% difference, previous study:[4] 17% difference). However, patients undergoing longer fusion had overall higher pre- and post-operative disability compared to those who underwent short fusion (current study: pre 53%, post 1-yr 37% and 2-yr 30%; previous study: pre 44%, post 27%). One subject who underwent 3-level fusion had ODI increase to above 81, bed-ridden classification, which did not occur in any short-fusion subjects. Operative time and blood loss were much higher with longer fusion when compared to the short fusion with only ALIF,[4] but similar to published 360° fusion for two-levels.[5] This was expected, but poses increasing risk of infection and need for transfusion. Finally, the long fusion cohort had a severe complication, acute renal failure eventually leading to death, which was not seen in the short fusion group.

There were limitations to the study. First, radiographic image analysis was not included in this study which did not allow the investigators to evaluate success of bony fusion, adjacent level disease, maintenance of disc height, or loss of fixation. In addition, the sample size was small and only 58% of patients initially identified through surgical logs had available medical records with pre- and post-operative evaluations. The two-year follow-up period was not sufficient for evaluation of full impact of the surgical treatment. In the future, it would be helpful to follow a larger group of patients prospectively for a longer period of time to evaluate function, pain, and risk of adjacent level disease or need for re-operation over time. It also would be useful to compare to a cohort of patients who choose non-operative treatment.

CONCLUSION

Arthrodesis for 3- and 4-level DDD is, on average, a successful surgery that shows clinically significant improvements in function and pain similar to fusion for 1- and 2-levels with low rates of re-operation. Patients with involvement of 3- or 4-levels have higher disability and pain, both pre- and post-operatively, compared to shorter fusion level involvement. Modern surgical approach and arthrodesis technique are improving patient outcomes in DDD, but further research is needed with greater number of patients and longer follow-up with radiographs to strengthen the evidence indicating a safe and effective procedure.

CONFLICT OF INTEREST STATEMENT

The authors of this study did not receive any funds, payments, or other personal benefits. No commitments or agreements were related in any way to the research subject or study investigators.

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