A Stratified Analysis of Multi-Level Direct Decompression of Degenerative Lumbar Central Stenosis: Is Fusion Needed?

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INTRODUCTION:
Surgical decompression of degenerative lumbar central stenosis (DLCS), in older patients has been shown to provide improved outcomes compared to conservative treatment. Despite the benefits of decompressive surgery, the potential for iatrogenic instability following laminectomy is a concern. This is further emphasized for patients who require multilevel decompression. However in the absence of significant instability, there still lacks an overall consensus of whether fusion is needed following decompression. The purpose of this study was to provide a stratified analysis based on age and relative intervertebral stability to compare multi-level decompression alone (MD) versus with fusion (MDF).

METHODS: Patients who fit inclusion criteria were retrospectively reviewed up to 1 year for perioperative and 1-year clinical outcomes. Outcome measures included baseline characteristics such as demographics, associated clinical diagnoses, and flex/ext intervertebral displacement (L1/L2, L3/L4, L4/L5, L5/S1). Surgical and clinical outcomes included number of levels decompressed, operative time (OT), estimated blood loss (EBL), length of stay (LOS), perioperative complications, 90-day readmissions, radiculopathy at 1-year follow-up, 1-year revision rates, and patient reported measures (PROMIS Physical Health, PROMIS Mental Health). Intervertebral displacement was measured as the sagittal translation of each vertebral segment from L1-S1 from flexion-extension films. Analyses performed between MD and MDF groups made use of independent sample t-tests and chi-square analyses. Propensity-score analysis (PSM) was conducted to match patients from each group based on number of levels decompressed and intervertebral stability.
RESULTS: A total of 131 patients were included in the study (37 MD, 94 MDF). Upon initial analysis, MD had more patients with a secondary diagnosis of disc herniation, whereas MDF had more patients with grade-1 spondylolisthesis (both $p<0.05$). Additionally, MDF also experienced greater L3/L4 (0.74 vs. 0.25 mm) and L4/L5 (1.24 vs. 0.53 mm) flex/ext displacement at baseline ($p<0.001$). MD had more levels decompressed, but also experienced significantly lower EBL, OT, and LOS ($p<0.05$). Following the surgery, MDF patients experienced a significantly higher rate of overall complications ($p=0.008$). At 1 year, MD patients were found to have higher incidence of radicular symptoms at 1-year follow-up, along with a higher rate of return to OR due to disk herniation ($p<0.05$). Despite lack of statistical significance, MDF patients recorded better mental health scores at 1 year compared to MD. After groups were propensity-matched based on the number of levels of decompressed and baseline intervertebral displacement (L1-S1), differences were no longer found in baseline characteristics between groups. EBL, OT, and LOS were all still significantly lower in the MD group ($p<0.001$), with a lower rate of postoperative complications. At 1 year, MD and MDF groups experienced equivalent clinical outcomes including radiculopathy, revision, and patient reported measures.
DISCUSSION AND CONCLUSION: Strategies taken in surgical treatment of DLCS should be taken with great care. While initial indications and extent of instability can simplify a surgeon's plan, the findings of our study suggest that in comparable elderly patients with equivalent baseline characteristics, multi-level decompression without fusion is a non-inferior alternative to fusion that can optimize perioperative outcomes with no difference at 1-year. Awareness of the factors associated with each type of procedure affecting morbidity and long-term patient course is important to provide improved clinical satisfaction.

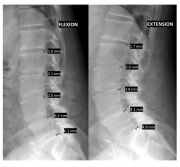

Figure 1. Intervertebral stability was measured as the absolute difference in measure of anterior or posterior subluxation of each lumbar vertebral segment between flexion and extension radiographs.

Table 1: Pre-PSM Baseline Characteristics

	No Fusion (N= 37)	With Fusion (N=94)	p-value
Age (years)	74.32±5.68	72.86±6.52	0.246
Gender (%F)	29.70%	47.90%	0.077
BMI	29.72±5.45	29.85±5.15	0.738
CCI	4.57±1.40	4.47±2.01	0.783
Current Smoker	2.70%	8.50%	0.444
Additional Indication			
Disc Herniation	**8(21.6%)**	**7(7.4%)**	**0.032**
Grade 1 Spondylolisthesis	**7(18.9%)**	**66(88.3%)**	**<0.001**
Degenerative Disc Disease	5(13.5%)	11(11.7%)	0.777
Flex-Ext Intervertebral Displacement (mm)			
L1/L2	0.18±0.39	0.28±0.99	0.309
L2/L3	0.42±0.65	0.42±0.53	0.986
L3/L4	**0.25±0.20**	**0.74±0.67**	**<0.001**
L4/L5	**0.53±0.75**	**1.24±1.08**	**<0.001**
L5/S1	0.34±0.45	0.48±0.65	0.277

Table 2: Pre-PSM Perioperative and Clinical Outcomes

	No Fusion (N= 37)	With Fusion (N=94)	p-value
Levels Decompressed	**1.86±0.35**	**2.95±0.45**	**0.015**
Operative Time (min)	**164.59±53.51**	**280.01±76.40**	**<0.001**
Estimated Blood Loss (mL)	**160.54±102.89**	**354.91±228.16**	**<0.001**
Length of Stay (days)	**2.38±1.66**	**4.81±2.46**	**<0.001**
Incidental Durotomy	4(10.3%)	7(7.4%)	0.201
Postoperative Complications	**4(10.8%)**	**32(34.0%)**	**0.008**
Cardiac	0(0%)	3(3.2%)	0.558
Neurological Deficit	1(2.7%)	3(3.2%)	1.000
Urinary Retention	2(8.1%)	13(13.8%)	0.555
Pulmonary	0(0%)	6(6.4%)	0.184
DVT	0(0%)	1(1.1%)	1.000
Ileus	0(0%)	7(7.4%)	0.190
90 Day Readmission	5(18.5%)	22(32.0%)	0.268
Radiculopathy At 1 Year Followup	**10(50.0%)**	**21(50.0%)**	**0.038**
Return to OR in 1 year	8(21.6%)	16(14.9%)	0.438
Days to Revision	322.88±344.28	366.57±179.25	0.751
Adjacent Segment Degeneration	1(2.7%)	5(5.3%)	1.000
Herniated Disk	**1(18.5%)**	**3(3.2%)**	**0.046**
Recurrent Stenosis	7(18.9%)	10(10.6%)	0.208
PROMIS Physical Health Baseline	39.44±2.71 (N=9)	37.39±7.37 (N=23)	0.255
PROMIS Physical Health 1 yr	40.67±6.87 (N=21)	41.91±10.09 (N=59)	0.697
PROMIS Mental Health Baseline	58.09±9.30 (N=9)	57.29±8.82 (N=20)	0.868
PROMIS Mental Health 1 yr	60.2±10.76 (N=21)	51.16±7.53 (N=56)	0.057

Table 3: Post-PSM Baseline Characteristics

	No Fusion (N=26)	With Fusion (N=26)	p-value
Age (years)	75.74±5.19	75.46±5.75	0.765
Gender (%F)	30.80%	26.90%	1.000
BMI	29.16±4.67	28.86±5.36	0.722
CCI	4.62±1.58	4.46±2.66	0.969
Current Smoker	3.80%	11.50%	0.613
Additional Indication			
Disc Herniation	4(15.4%)	2(7.7%)	0.668
Grade 1 Spondylolisthesis	6(23.1%)	13(50.0%)	0.083
Degenerative Disc Disease	3(11.5%)	5(19.2%)	0.703
Flex-Ext Intervertebral Displacement (mm)			
L1/L2	0.17±0.19	0.1±0.60	0.271
L2/L3	0.54±0.41	0.47±0.72	0.440
L3/L4	0.27±0.21	0.32±0.39	0.592
L4/L5	0.65±0.46	0.54±0.66	0.583
L5/S1	0.38±0.16	0.46±0.68	0.873

Table 4: Post-PSM Perioperative and Clinical Outcomes

	No Fusion (N= 26)	With Fusion (N=26)	p-value
Levels Decompressed	2.12±0.59	2.58±0.57	0.413
Operative Time (min)	**158.58±42.64**	**289.02±74.51**	**<0.001**
Estimated Blood Loss (mL)	**132.58±52.65**	**401.38±137.81**	**<0.001**
Length of Stay (days)	**2.58±1.49**	**4.69±1.81**	**<0.001**
Incidental Durotomy	3(11.5%)	1(3.8%)	0.418
Postoperative Complications	2(7.7%)	8(30.8%)	0.075
Cardiac	0(0%)	2(7.7%)	0.490
Neurological Deficit	1(3.8%)	2(7.7%)	1.000
Urinary Retention	1(3.8%)	3(11.8%)	0.610
Pulmonary	0(0%)	1(3.8%)	1.000
DVT	0(0%)	0(0%)	--
Ileus	0(0%)	0(0%)	--
90 Day Readmission	3(11.2%)	2(7.7%)	0.419
Radiculopathy At 1 Year Followup	10 (54.2%)	10(38.5%)	0.205
Return to OR in 1 year	7(26.9%)	3(30.8%)	0.763
Days to Revision	306.29±167.57	372.00±202.33	0.523
Adjacent Segment Degeneration	1(3.8%)	3(11.5%)	0.610
Herniated Disk	4(15.4%)	0(0%)	0.110
Recurrent Stenosis	3(11.2%)	3(11.5%)	0.465
PROMIS Physical Health Baseline	38.31±2.62 (N=7)	38.43±7.38(N=8)	0.408
PROMIS Physical Health 1 yr	42.93±6.62 (N=9)	37.98±10.16 (N=13)	0.113
PROMIS Mental Health Baseline	47.29±9.03 (N=7)	45.80±11.25 (N=8)	0.790
PROMIS Mental Health 1 yr	49.28±5.99 (N=9)	50.25±8.40 (N=13)	0.771