Comparing Patient-Reported Outcomes in Patients Undergoing Lumbar Fusion for Isthmic Spondylolisthesis with Predominant Back Pain versus Predominant Leg Pain Symptoms

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INTRODUCTION: Prior studies comparing postoperative clinical outcomes in patients undergoing lumbar fusion with predominant back pain versus predominant leg pain symptoms have been limited in the strength of their conclusions. We aim to compare perioperative and postoperative mean patient-reported outcome measures (PROMs) and minimum clinically important difference (MCID) achievement following anterior lumbar interbody fusion (ALIF) and transforaminal lumbar interbody fusion (TLIF) for isthmic spondylolisthesis in patients presenting with predominant back pain symptoms versus predominant leg pain symptoms.

METHODS: A maintained academic single-surgeon database was retrospectively reviewed for lumbar procedures between June 2005 and December 2021. Inclusion criteria was set as primary, elective, single-level anterior or transforaminal lumbar fusion procedures for isthmic spondylolisthesis. Patients undergoing surgery indicated for infectious, malignant, traumatic etiologies, preoperative back pain equivalent to preoperative leg pain, or patients undergoing surgery for degenerative spondylolisthesis, recurrent herniated nucleus pulposus, or degenerative scoliosis were excluded. Additionally, if patients lacked preoperative survey completion or did not complete a 6-month follow-up survey, they were excluded. PROMs were administered at preoperative and 6-week, 12-week, 6-month, 1-year, and 2-year postoperative time-points and included Visual Analogue Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), 12-Item Short Form Physical and Mental Composite Score (SF-12 PCS/MCS), and Patient-Reported Outcome Measurement Information System-Physical Function (PROMIS-PF). Postoperative complications were collected for each cohort as well. Patients were grouped into predominant back pain and predominant leg pain cohorts based on preoperative pain surveys. Predominant back pain cohort consisted of patients with preoperative VAS back > preoperative VAS leg. Predominant leg pain cohort consisted of patients with preoperative VAS leg > preoperative VAS back. Demographic, perioperative characteristics, and mean PROM scores were compared among groups using inferential statistics. Postoperative improvement from preoperative baseline within each cohort was assessed with paired samples t-test. Achievement of Minimum Clinical Important Difference (MCID) was determined by comparing ΔPROM scores to previously established threshold values. MCID achievement rates were compared between groups with chi-squared analysis.

RESULTS:

A total of 143 patients met inclusion criteria with 65 patients in the predominant back pain cohort and 78 patients in the predominant leg pain cohort. Patients in the predominant leg pain cohort demonstrated significantly greater mean postoperative length of stay, estimated blood loss, operative duration, and narcotic consumption on POD0 &1 ($p \leq 0.028$, all). Preoperative mean PROM scores were similar for all PROMs collected except higher VAS leg in the predominant leg pain cohort ($p < 0.001$). Cohorts demonstrated significant mean postoperative differences for the following PROMs at the following postoperative timepoints: VAS leg at 1-year and 2-years, ODI at 2-years, and SF-12 MCS at 1-year with all differences favoring predominant back pain cohort ($p \leq 0.042$, all). Predominant back pain patient cohort demonstrated improvement from respective preoperative baseline to the 2-year timepoint for all postoperative PROMs except ODI at 6-weeks, SF-12 MCS at 6-weeks, 12-weeks, 1-year, and 2-years, SF-12 PCS at 6-weeks, and PROMIS-PF at 6-weeks ($p \leq 0.033$, all). Predominant leg pain patient cohort demonstrated significant improvement from respective preoperative baseline to 2-year timepoint for all postoperative PROMs except VAS back at 2-years, ODI at 6-weeks and 2-years, SF-12 MCS at 1 and 2-years, and PROMIS-PF and SF-12 PCS at 6-weeks ($p \leq 0.048$, all). Both cohorts achieved overall MCID greater than 50% in VAS back, VAS leg, ODI, SF-12 PCS, and PROMIS-PF. Significant differences were noted between cohorts for rate of achievement of MCID for the following PROMs: VAS back at 2-years and VAS leg at 6-weeks, 12-weeks, 6-months, and overall ($p \leq 0.036$, all).

DISCUSSION AND CONCLUSION: Results from our study suggest that patients undergoing lumbar fusion at L4-L5 and L5-S1 for isthmic spondylolisthesis with predominant back pain symptoms may demonstrate improved long-term clinical outcomes for reported back pain, leg pain, and disability when compared to patients presenting for surgery with predominant leg pain symptoms. This subset of patients may additionally experience a reduced postoperative length of stay and consume fewer narcotics on day of surgery and POD1.

Table 1. Patient Demographics

	Total (n=143)	Predominant Back Pain (n=65)	Predominant Leg Pain (n=78)	*p-value
Age (mean ±SD)	50.7 ± 12.8	50.4 ± 12.9	50.9 ± 12.8	0.805
Gender				
Female	43.4% (62)	41.5% (27)	44.9% (35)	0.689
Male	56.6% (81)	58.5% (38)	55.1% (43)	
Body Mass Index Category (BMI)				0.408
<30 kg/m^2	54.6% (78)	50.8% (33)	57.7% (45)	
≥30 kg/m^2	45.4% (65)	49.2% (32)	42.3% (33)	
Body Mass Index (Mean ± SD)	30.5 ± 6.5	30.8 ± 6.9	30.2 ± 6.3	0.565
Ethnicity				
Caucasian	73.2% (104)	71.9% (46)	71.1% (58)	
African-American	9.9% (14)	7.8% (5)	13.2% (9)	
Hispanic	10.6% (15)	9.4% (6)	8.6% (9)	
Asian	3.5% (5)	6.3% (4)	2.2% (1)	0.332
Other	2.8% (4)	4.7% (3)	4.9% (1)	
Smoking Status				
Non-Smoker	83.2% (119)	83.1% (54)	83.3% (65)	0.967
Smoker	16.8% (24)	16.9% (11)	16.7% (13)	
Diabetes				
Non-Diabetic	93.0% (133)	90.8% (59)	94.9% (74)	0.338
Diabetic	7.0% (10)	9.2% (6)	5.1% (4)	
Hypertensive Status				
Non-Hypertensive	67.8% (97)	69.2% (45)	66.7% (52)	0.744
Hypertensive	32.2% (46)	30.8% (20)	33.3% (26)	
ASA Classification				
<3	83.9% (120)	81.5% (53)	85.9% (67)	0.480
>= 3	16.1% (23)	18.5% (12)	14.1% (11)	
Insurance				
Medicare/Medicaid	7.7% (11)	6.2% (4)	9.0% (7)	
Workers' Compensation	29.4% (42)	24.6% (16)	33.3% (26)	0.362
Private	62.9% (90)	69.2% (45)	57.7% (45)	

ASA = American Society of Anesthesiologists
*p-value calculated with Student's t-test for continuous variables and chi-square for categorical variables

Table 2. Perioperative Characteristics

	Total (n=143)	Predominant Back Pain (n=65)	Predominant Leg Pain (n=78)	*p-value
Spinal Pathology				
Central Stenosis	88.8% (127)	92.3% (60)	85.9% (67)	0.226
Foraminal Stenosis	46.2% (66)	64.6% (42)	30.8% (24)	**<0.001**
Isthmic Spondylolisthesis	100.0% (143)	100.0% (65)	100.0% (78)	-
Fusion Procedure				0.598
MIS-TLIF (2)	74.8% (107)	76.9% (50)	73.1% (57)	
ALIF (3)	25.2% (36)	23.1% (15)	26.9% (21)	
Fusion Level				0.657
L2-L3	0.0% (0)	0.0% (0)	0.0% (0)	
L3-L4	0.0% (0)	0.0% (0)	0.0% (0)	
L3-L5	0.0% (0)	0.0% (0)	0.0% (0)	
L4-L5	21.7% (31)	20.0% (13)	23.1% (18)	
L4-S1	0.0% (0)	0.0% (0)	0.0% (0)	
L5-S1	78.3% (112)	80.0% (52)	76.9% (60)	
Number of Levels Operated				-
Single Level (0)				
Multiple Levels (1)				
Operative Time (mean ±SD; min)	153.5 ± 47.7	143.9 ± 41.2	161.4 ± 51.5	**0.028**
Estimated Blood Loss (mean ±SD; mL)	95.4 ± 99.0	68.1 ± 38.3	116.8 ± 123.9	**0.004**
Length of Stay (mean ±SD; hours)	46.5 ± 40.7	33.0 ± 20.2	57.0 ± 48.9	**<0.001**
Post-operative Day of Discharge (POD)				
POD0	9.8% (13)	17.2% (10)	4.0% (3)	**0.001**
POD1	42.1% (56)	56.9% (33)	30.7% (23)	
POD2	23.3% (31)	13.8% (8)	30.7% (23)	
POD3	18.8% (25)	12.1% (7)	24.0% (18)	
POD4	3.8% (5)	0.0% (0)	6.7% (5)	
Postoperative VAS Pain Score				
POD0	5.3 ± 1.7	5.2 ± 1.9	5.4 ± 1.6	0.463
POD1	4.8 ± 1.9	5.0 ± 1.6	4.7 ± 2.0	0.491
Postoperative Narcotic Consumption (OME)				
POD0	78.6 ± 64.9	56.3 ± 30.4	97.2 ± 78.9	**<0.001**
POD1	63.4 ± 78.6	44.7 ± 34.9	79.0 ± 99.2	**0.009**

OME = Oral Morphine Equivalents; POD = Postoperative Day

Re-hospitalization = Defined as returning to hospital within 6-weeks of surgery with a surgical related complaint.
*p-value calculated using Student's t-test for continuous variables and chi-square for categorical variables
Boldface indicates statistical significance.

Table 3. Patient Reported Outcome Measures

	Predominant Back Pain Mean ±SD	Predominant Back Pain Post-operative PROM Improvement	Predominant Leg Pain Mean ±SD	Predominant Leg Pain Post-operative PROM Improvement	*p-value
VAS Back					
Preoperative	6.9 ± 1.9	-	6.2 ± 2.6	-	
6-weeks	4.5 ± 2.5	**<0.001**	3.9 ± 2.4	**<0.001**	0.079
12-weeks	4.1 ± 2.6	**<0.001**	3.3 ± 2.3	**<0.001**	0.144
6-months	3.6 ± 2.4	**<0.001**	3.4 ± 2.9	**<0.001**	0.098
1-year	2.5 ± 2.3	**<0.001**	3.1 ± 2.9	**0.011**	0.684
2-year	2.4 ± 2.1	**<0.001**	3.0 ± 3.5	0.125	0.373
VAS Leg					**0.023**
Preoperative	4.2 ± 2.7	-	6.6 ± 2.3	-	
6-weeks	3.2 ± 2.9	**0.026**	2.9 ± 2.7	**<0.001**	**<0.001**
12-weeks	3.0 ± 2.8	**0.022**	2.3 ± 2.4	**<0.001**	0.487
6-months	2.3 ± 2.8	**<0.001**	2.3 ± 2.6	**<0.001**	0.133
1-year	1.1 ± 1.9	**<0.001**	2.7 ± 3.1	**<0.001**	0.830
2-year	1.6 ± 2.0	**<0.001**	3.4 ± 4.0	**0.008**	**0.042**
ODI					**0.022**
Preoperative	39.8 ± 14.8	-	40.6 ± 18.5	-	
6-weeks	34.5 ± 16.7	0.116	34.9 ± 19.7	0.084	0.812
12-weeks	27.0 ± 17.5	**<0.001**	24.5 ± 18.3	**<0.001**	0.916
6-months	25.2 ± 19.8	**<0.001**	23.0 ± 24.3	**<0.001**	0.688
1-year	16.1 ± 18.8	**<0.001**	25.3 ± 25.4	**0.002**	0.653
2-year	13.5 ± 13.3	**<0.001**	28.2 ± 29.5	0.186	0.065
SF-12 MCS					**0.036**
Preoperative	50.3 ± 11.1	-	47.0 ± 11.6	-	
6-weeks	52.0 ± 12.0	0.083	53.4 ± 10.1	**0.048**	0.177
12-weeks	54.2 ± 10.4	0.332	55.7 ± 11.9	**0.031**	0.526
6-months	54.3 ± 11.3	**0.033**	55.4 ± 7.9	**0.020**	0.510
1-year	54.7 ± 7.8	0.054	49.4 ± 10.2	0.209	0.760
2-year	54.6 ± 8.8	0.996	51.3 ± 8.1	0.088	**0.039**
SF-12 PCS					0.303
Preoperative	31.7 ± 9.5	-	31.5 ± 9.0	-	
6-weeks	32.1 ± 8.6	0.686	32.4 ± 7.9	0.797	0.891
12-weeks	35.5 ± 9.7	**<0.001**	37.9 ± 9.1	**0.040**	0.940
6-months	37.6 ± 9.3	**<0.001**	40.0 ± 10.7	**0.007**	0.273
1-year	45.4 ± 9.7	**<0.001**	40.0 ± 12.3	**<0.001**	0.099
2-year	41.1 ± 11.2	**0.002**	39.3 ± 16.0	**0.011**	0.183
PROMIS-PF					0.859
Preoperative	37.1 ± 5.6	-	35.9 ± 5.7	-	
6-weeks	37.9 ± 6.1	0.907	37.4 ± 7.2	0.458	0.420
12-weeks	40.6 ± 6.5	**0.026**	42.4 ± 6.7	**0.011**	0.601
6-months	43.3 ± 5.7	**<0.001**	45.6 ± 10.9	**0.002**	0.322
1-year	48.2 ± 8.6	**<0.001**	46.7 ± 11.4	**<0.001**	0.381
2-year	48.5 ± 7.1	**<0.001**	47.8 ± 8.6	**0.002**	0.304
					0.623

*p-value calculated by Student's t-test
Boldface indicates statistical significance.

Table 4. MCID Achievement

	Predominant Back Pain	Predominant Leg Pain	*p-value
VAS Back			
6-weeks	45.8%	53.3%	0.417
12-weeks	54.2%	51.5%	0.775
6-months	64.0%	50.8%	0.156
1-year	75.0%	50.0%	0.086
2-year	80.0%	27.8%	**0.008**
Overall	78.3% (47)	66.7% (52)	0.131
VAS Leg			
6-weeks	32.7%	56.7%	**0.036**
12-weeks	24.5%	62.1%	**0.001**
6-months	37.3%	65.4%	**0.019**
1-year	61.5%	60.0%	0.916
2-year	66.7%	66.7%	1.000
Overall	49.2% (30)	79.4% (27)	**0.004**
ODI			
6-weeks	24.5%	18.9%	0.538
12-weeks	41.7%	39.4%	0.838
6-months	53.6%	56.7%	0.783
1-year	70.4%	60.0%	0.458
2-year	75.0%	42.9%	0.098
Overall	59.4% (38)	60.0% (24)	0.950
SF-12 MCS			
6-weeks	22.7%	18.2%	0.670
12-weeks	11.9%	26.3%	0.159
6-months	28.6%	21.1%	0.547
1-year	25.9%	35.3%	0.507
2-year	5.3%	28.6%	0.065
Overall	30.9% (17)	33.3% (10)	0.819
SF-12 PCS			
6-weeks	48.8%	36.4%	0.338
12-weeks	63.4%	52.6%	0.428
6-months	68.6%	68.4%	0.991
1-year	81.5%	82.4%	0.942
2-year	73.7%	50.0%	0.162
Overall	79.6% (43)	83.3% (25)	0.679
PROMIS-PF			
6-weeks	29.0%	36.8%	0.566
12-weeks	48.0%	46.2%	0.914
6-months	65.4%	73.3%	0.598
1-year	81.0%	61.5%	0.212
2-year	75.0%	60.0%	0.452
Overall	81.6% (31)	81.8% (18)	0.982

*p-value calculated with chi-squared analysis
Boldface indicates statistical significance