Influence of Preoperative Symptom Duration on Postoperative Clinical Outcomes and Trajectory in Patients Undergoing Minimally Invasive Transforaminal Lumbar Interbody Fusion for Isthmic Spondylolisthesis

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INTRODUCTION: Prior studies that have assessed how duration of symptoms preoperatively affects patient postoperative clinical outcomes postoperatively following minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) have been limited in the strength of their conclusions due to the inclusion of heterogeneous spinal pathology. We aim to compare perioperative and postoperative mean patient-reported outcome measures (PROMs) and minimum clinically important difference (MCID) achievement following MIS-TLIF for isthmic spondylolisthesis in patients stratified by preoperative symptom duration.

METHODS:

A retrospective review of a maintained attending academic single-surgeon database was conducted for lumbar procedures between June 2005 and December 2021. Inclusion criteria was set as primary, elective, single-level or multi-level MIS-TLIF procedures for isthmic spondylolisthesis. Patients undergoing a revision procedure, or surgery indicated for infectious, malignant, or traumatic etiologies were excluded. Further, patients undergoing surgery for primary indication of recurrent herniated nucleus pulposus, degenerative spondylolisthesis, or degenerative scoliosis were excluded. Additionally, patients without preoperative duration of symptom data were excluded as well.

Duration of symptoms was defined as the time span from patient-reported onset of symptoms to the date of surgery. Patient demographics, perioperative characteristics, and PROMs were collected. PROMs were administered at preoperative and 6-week, 12-week, 6-month, 1-year, and 2-year postoperative timepoints and included Patient-Reported Outcomes Measurement Information System-Physical Function (PROMIS-PF), Visual Analogue Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), and 12-Item Short Form Physical and Mental Composite Score (SF-12 PCS/MCS).

Patients were grouped into two cohorts, utilizing 365 days a duration of symptom cutoff – symptoms duration <365 days or symptom duration ≥ 365 days. Demographic, perioperative characteristics, and mean PROMs 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.

RESULTS:

A total of 151 patients met inclusion criteria with 41 patients in the symptom duration <365 patient cohort and 110 patients in the symptom duration ≥365 patient cohort. A greater proportion of patients in the symptom duration <365 patient cohort had workers' compensation status ($p \leq 0.007$). A significantly greater proportion of patients in the symptom duration <365 cohort were discharged on postoperative day 0 (18.2% vs. 5.0%).

Preoperative mean PROM scores were similar for all PROMs collected with exception of preoperative ODI and SF-12 MCS noted to be significantly worsened in the symptom duration <365 day cohort ($p \leq 0.024$, all). Cohorts demonstrated no significant mean postoperative differences for all PROMs collected at all postoperative follow-up timepoints with exception of VAS back at 1-year, VAS leg at 2-years, ODI at 2-years, and PROMIS-PF at 12-weeks, 1-years, and 2-years ($p \leq 0.036$, all). Symptom duration <365 days patient cohort demonstrated significant improvement from preoperative baseline to the 2-year timepoint for all PROMs collected at all individual postoperative timepoints except ODI at 2-years, SF-12 MCS at 6-weeks, 6-months, 1-year, and 2-years, SF-12 PCS through 6-months, and PROMIS-PF at 6-weeks, 12-weeks, and 2-years ($p \leq 0.048$, all). Symptom Duration ≥365 patient cohort demonstrated significant improvement from preoperative baseline to 2-year timepoint for all PROMs collected at all individual postoperative timepoints with the exception of 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 ($p \leq 0.028$, all). Both cohorts achieved overall MCID greater than 50% for the following HRQOL measures: VAS back, VAS leg, ODI, SF-12 PCS, and PROMIS-PF.

DISCUSSION AND CONCLUSION: Results from our study may suggest improved short-term physical function improvement and long-term mean outcomes for leg pain and disability in patients undergoing MIS-TLIF for isthmic spondylolisthesis in patients presenting for surgery with longer symptom duration preoperatively.

Table 1. Patient Demographics -

	Total (n=151)	Symptom Duration <365 days (n=41)	Symptom Duration ≥365 days (n=110)	*p-value
Age (mean ±SD)	50.2 ± 13.2	47.0 ± 12.7	51.4 ± 13.2	0.071
Gender				
Female	44.4% (67)	34.2% (14)	48.2% (53)	0.123
Male	55.6% (84)	65.9% (27)	51.8% (57)	
Body Mass Index Category (BMI)				0.230
<30 kg/m²	54.3% (82)	46.3% (19)	57.3% (63)	
≥30 kg/m²	45.7% (69)	53.7% (22)	42.7% (47)	
Body Mass Index (Mean ± SD)	30.4 ± 6.1	31.1 ± 5.2	30.2 ± 6.4	0.409
Ethnicity				
Caucasian	64.0% (96)	58.5% (24)	66.1% (72)	
African-American	14.0% (21)	12.2% (5)	14.7% (16)	
Hispanic	15.3% (23)	26.8% (11)	11.0% (12)	
Asian	2.7% (4)	0.0% (0)	3.7% (4)	0.130
Other	4.0% (6)	2.4% (1)	4.6% (5)	
Smoking Status				
Non-Smoker	86.8% (131)	90.2% (37)	85.5% (94)	0.440
Smoker	13.3% (20)	9.8% (4)	14.6% (16)	
Diabetes				
Non-Diabetic	94.0% (142)	92.7% (38)	94.6% (104)	0.667
Diabetic	6.0% (9)	7.3% (3)	5.5% (6)	
Hypertensive Status				
Non-Hypertensive	69.1% (105)	70.7% (29)	69.1% (76)	0.846
Hypertensive	30.5% (46)	29.3% (12)	30.9% (34)	
ASA Classification				
<3	82.7% (124)	85.4% (35)	81.7% (89)	0.592
>= 3	17.3% (26)	14.6% (6)	18.4% (20)	
Insurance				
Medicare/Medicaid	7.3% (11)	4.9% (2)	8.2% (9)	
Workers' Compensation	33.8% (51)	53.7% (22)	26.4% (29)	**0.007**
Private	58.9% (89)	41.5% (17)	65.5% (72)	

ASA = American Society of Anesthesiologists
Boldface indicates statistical significance

Table 2. Perioperative Characteristics

	Total (n=151)	Symptom Duration <365 (n=41)	Symptom Duration >=365 (n=110)	*p-value
Spinal Pathology				
Central Stenosis	87.4% (132)	80.5% (33)	90.0% (99)	0.117
Foraminal Stenosis	39.1% (59)	51.2% (21)	34.6% (38)	0.062
Isthmic Spondylolisthesis	100.0% (151)	100.0% (41)	100.0% 110)	
Fusion Procedure				0.082
TLIF	100.0% (151)	100.0% (41)	100.0% 110)	
Fusion Level				0.628
L4-L5	26.5% (40)	24.4% (10)	27.3% (30)	
L4-S1	1.3% (2)	0.0% (0)	1.8% (2)	
L5-S1	72.2% (109)	75.6% (31)	70.9% (78)	
Number of Operated Levels				0.385
Single-Level	98.7% (149)	100.0% (41)	98.2% (108)	
Multiple Levels	1.3% (2)	0.0% (0)	1.8% (2)	
Operative Time (Mean±SD; min)	147.5 ± 39.9	146.5 ± 29.0	147.9 ± 43.4	0.852
Estimated Blood Loss (Mean±SD; mL)	85.8 ± 91.9	59.7 ± 23.4	94.4 ± 104.0	**0.049**
Length of Stay (Mean±SD; hours)	50.9 ± 42.1	44.7 ± 25.8	52.9 ± 46.2	0.331
Post-operative Day of Discharge (POD)				**0.025**
POD0	8.3% (11)	18.2% (6)	5.0% (5)	
POD1	36.8% (49)	24.2% (8)	41.0% (41)	
POD2	24.8% (33)	27.3% (9)	24.0% (24)	
POD3	19.6% (26)	30.3% (10)	16.0% (16)	
POD4	6.8% (9)	0.0% (0)	9.0% (9)	
Postoperative VAS Pain Score				0.232
POD0	5.4 ± 1.8	5.7 ± 1.9	5.3 ± 1.8	
POD1	4.9 ± 1.9	5.8 ± 1.6	4.7 ± 1.9	**0.004**
Postoperative Narcotic Consumption (OME)				
POD0	82.3 ± 69.3	68.4 ± 54.2	87.6 ± 73.8	0.132
POD1	62.7 ± 63.7	52.9 ± 54.8	66.3 ± 66.6	0.250

OME = Oral Morphine Equivalents; POD = Postoperative Day
Boldface indicates statistical significance

Table 3. Patient Reported Outcome Measures

	Symptom Duration <365 Mean ± SD	Symptom Duration <365	Symptom Duration >=365 Mean ± SD	Symptom Duration >=365	*p-value
		Post-operative PROM Improvement		Post-operative PROM Improvement	
VAS Back					
Preoperative	6.8 ± 2.4		6.7 ± 2.2		0.906
6-weeks	4.6 ± 2.9	**<0.001**	4.1 ± 2.5	**<0.001**	0.279
12-weeks	4.3 ± 2.9	**<0.001**	3.4 ± 2.4	**<0.001**	0.169
6-months	4.5 ± 2.7	**<0.001**	3.5 ± 2.8	**<0.001**	0.161
1-year	4.2 ± 3.1	**0.002**	2.4 ± 2.2	**<0.001**	**0.036**
2-year	5.3 ± 2.9	**0.010**	3.1 ± 3.1	**0.003**	0.064
VAS Leg					
Preoperative	5.8 ± 2.8	-	5.3 ± 2.9	-	0.467
6-weeks	3.6 ± 3.4	**<0.001**	3.4 ± 3.2	**<0.001**	0.762
12-weeks	3.5 ± 3.4	**0.001**	2.4 ± 2.7	**<0.001**	0.161
6-months	3.3 ± 3.2	**<0.001**	2.4 ± 2.9	**<0.001**	0.254
1-year	2.9 ± 3.0	**<0.001**	1.9 ± 2.8	**<0.001**	0.301
2-year	4.8 ± 3.7	**0.048**	2.3 ± 2.6	**<0.001**	**0.037**
ODI					
Preoperative	47.9 ± 18.8		39.4 ± 16.2		**0.024**
6-weeks	41.5 ± 21.6	**0.013**	35.3 ± 19.0	0.210	0.176
12-weeks	32.8 ± 17.8	**<0.001**	25.4 ± 19.4	**<0.001**	0.117
6-months	32.4 ± 23.4	**<0.001**	22.6 ± 21.4	**<0.001**	0.073
1-year	29.1 ± 22.3	**0.004**	19.7 ± 20.9	**<0.001**	0.163
2-year	42.5 ± 25.8	0.243	16.5 ± 17.8	**<0.001**	**0.002**
SF-12 MCS					
Preoperative	41.9± 12.4	-	49.6 ± 10.9	-	**0.004**
6-weeks	47.0 ± 13.7	0.063	51.6 ± 12.4	0.245	0.210
12-weeks	47.7 ± 15.9	**0.047**	53.4 ± 11.7	0.526	0.163
6-months	46.7 ± 16.0	0.206	52.7 ± 10.8	**0.028**	0.160
1-year	47.4 ± 12.0	0.075	53.4 ± 8.1	0.147	0.077
2-year	48.3 ± 9.4	0.115	52.8 ± 8.6	0.736	0.202
SF-12 PCS					
Preoperative	31.4 ± 9.1	-	32.8 ± 9.9	-	0.503
6-weeks	30.3 ± 6.1	0.763	31.9 ± 9.2	0.924	0.528
12-weeks	33.1 ± 8.0	0.821	38.2 ± 10.1	**<0.001**	0.093
6-months	37.1 ± 10.4	0.113	39.3 ± 11.5	**<0.001**	0.503
1-year	38.3 ± 11.5	**0.002**	41.4 ± 13.3	**<0.001**	0.508
2-year	34.7 ± 14.1	**0.031**	41.9 ± 12.9	**0.020**	0.176
PROMIS-PF					
Preoperative	34.6 ± 6.7		36.9 ± 5.7		0.218
6-weeks	33.3 ± 8.5	0.175	38.7 ± 7.6	0.891	0.064
12-weeks	35.4 ± 9.0	0.222	42.7 ± 7.2	**<0.001**	**0.019**
6-months	43.4 ± 8.6	**<0.001**	44.5 ± 7.1	**<0.001**	0.671
1-year	40.4 ± 12.1	**0.003**	49.8 ± 9.8	**<0.001**	**0.031**
2-year	37.2 ± 10.2	0.133	48.6 ± 6.9	**<0.001**	**0.007**

Boldface indicates statistical significance

Table 4. MCID Achievement

	Symptom Duration <365	Symptom Duration >=365	*p-value
VAS Back			
6-weeks	42.9%	53.1%	0.351
12-weeks	55.0%	55.6%	0.965
6-months	58.8%	56.8%	0.877
1-year	61.5%	61.5%	1.000
2-year	45.5%	56.3%	0.581
Overall	68.8% (22)	71.4% (65)	0.775
VAS Leg			
6-weeks	42.9%	50.0%	0.585
12-weeks	47.4%	45.7%	0.900
6-months	62.5%	54.2%	0.561
1-year	61.5%	66.7%	0.750
2-year	62.5%	70.6%	0.686
Overall	73.1% (19)	66.1% (39)	0.524
ODI			
6-weeks	33.3%	28.0%	0.626
12-weeks	42.9%	52.2%	0.479
6-months	47.6%	64.7%	0.179
1-year	57.1%	66.7%	0.548
2-year	50.0%	64.7%	0.453
Overall	59.4% (19)	63.9% (39)	0.666
SF-12 MCS			
6-weeks	33.3%	16.3%	0.160
12-weeks	33.3%	17.1%	0.237
6-months	37.5%	22.9%	0.392
1-year	55.6%	22.2%	0.060
2-year	22.2%	13.6%	0.555
Overall	47.6% (10)	30.8% (16)	0.174
SF-12 PCS			
6-weeks	33.3%	40.5%	0.626
12-weeks	41.7%	61.8%	0.227
6-months	62.5%	68.6%	0.741
1-year	88.9%	74.1%	0.355
2-year	55.6%	59.1%	0.856
Overall	66.7% (14)	78.4% (40)	0.295
PROMIS-PF			
6-weeks	30.0%	29.2%	0.961
12-weeks	33.3%	68.4%	0.080
6-months	88.9%	66.7%	0.207
1-year	85.7%	84.2%	0.925
2-year	50.0%	70.6%	0.432
Overall	92.9% (13)	84.4% (27)	0.432

*p-value calculated with chi-squared analysis