Influence of Preexisting Diabetes on Postoperative Clinical Outcomes and Trajectory in Patients Undergoing Lumbar Fusion: Cohort Matched Analysis

Kevin C Jacob, Madhav Patel, Timothy J Hartman, James Nie[1], Alexander W Parsons, Keith R. Macgregor[2], Omolabake Oyetayo[1], Eileen Zheng, Kern Singh[2]
[1]Rush University Medical Center, [2]Midwest Orthopaedics At Rush

INTRODUCTION: While prior studies have assessed the role of diabetes on outcomes following lumbar spine fusion, the strength of their conclusions have been limited by the absence of inclusion of differing fusion techniques as well as absence of cohort matching for inherent demographic differences at baseline. 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), lateral lumbar interbody fusion (LLIF) and transforaminal lumbar interbody fusion (TLIF) in patients stratified by pre-existing diabetes in a cohort matched study design.

METHODS: A retrospective review of a prospectively 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 lumbar fusion procedures for degenerative lumbar spinal pathology. Patients undergoing surgery indicated for infectious, malignant, or traumatic etiologies were excluded. Patient demographics, perioperative characteristics, complications, and PROMs were collected. 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), and 12-Item Short Form Physical and Mental Composite Score (SF-12 PCS/MCS). Patients were grouped into two cohorts, depending on pre-existing diabetic status preoperatively. Propensity score matching was conducted to account for baseline differences between cohorts. Following matching, 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. MCID achievement rates were compared between groups with chi-squared analysis.

RESULTS: Following matching, no significant differences existed between cohorts with exception for difference of pre-existing diabetes preoperatively**.** Significantly greater rates of altered mental status were noted in diabetic patient cohort (p =0.034)**.** Preoperative mean PROM scores were similar for all PROMs collected. Cohorts demonstrated no significant mean postoperative differences for all PROMs collected with exception of VAS leg at 12-weeks and 6-months and SF-12 PCS at 12-weeks, (p ≤0.019, all)**.** Non-diabetic patient cohort demonstrated improvement from respective preoperative baseline to the 2-year time point for all PROMs collected at all individual postoperative timepoints with the exception of SF-12 MCS at 2-years, and SF-12 PCS at 6-weeks (p ≤0.044, all). Diabetic patient cohort demonstrated significant improvement from respective preoperative baseline to 2-year time point for all PROMs collected at all individual postoperative timepoints with the exception of VAS back at 2-years, ODI at 6-weeks and 2-years, SF-12 MCS 6-weeks and 2-years, and SF-12 PCS at 6 and 12-weeks (p ≤0.049, all). Both cohorts achieved overall MCID greater than 50% in VAS back, VAS leg, ODI, and SF-12 PCS. No significant differences were noted between cohort rate of achievement of a MCID.

DISCUSSION AND CONCLUSION: Results for our study may suggest inferior short term (6-week) postoperative improvement for disability, mental health, and physical function as well decreased ability to maintain long term (2-year) post-operative progress for back pain and disability in diabetics undergoing lumbar fusion. These patients may also suffer from inferior clinical outcomes for leg pain in the intermediate postoperative period (12-weeks-6-months).

Table 1. Patient Demographics - Matched

	Total (n=238)	Non-Diabetic (n=157)	Diabetic (n=81)	*p-value
Age (mean ±SD)	57.8 ± 10.9	57.7 ± 11.3	58.9 ± 10.1	0.932
Gender				
Female	27.3% (65)	27.4% (43)	27.2% (22)	0.978
Male	72.7% (173)	72.6% (114)	72.8% (59)	
Body Mass Index Category				
<30 kg/m²	57.8% (90)	59.2% (60)	57.8% (39)	0.859
≥30 kg/m²	62.2% (148)	61.8% (97)	63.0% (51)	
Body Mass Index (Mean ± SD)	32.7 ± 6.3	32.6 ± 6.7	32.9 ± 5.8	0.676
Ethnicity				
Caucasian	74.8% (176)	76.4% (120)	69.1% (56)	
African-American	11.3% (27)	11.5% (18)	11.1% (9)	
Hispanic	9.2% (22)	8.3% (13)	11.1% (9)	
Asian	2.1% (5)	1.9% (3)	2.5% (2)	0.431
Other	3.4% (8)	1.9% (3)	6.2% (5)	
Smoking Status				
Non-Smoker	77.7% (185)	79.6% (125)	74.1% (60)	0.330
Smoker	22.3% (53)	20.4% (32)	25.9% (21)	
Diabetes				
Non-Diabetic	66.0% (157)	100.0% (157)	0.0% (0)	**<0.001**
Diabetic	34.0% (81)	0.0% (0)	100.0% (81)	
Hypertensive Status				
Non-Hypertensive	29.4% (70)	29.7% (45)	30.9% (25)	0.724
Hypertensive	70.6% (168)	71.3% (112)	69.1% (56)	
ASA Classification				
<3	57.1% (136)	60.5% (95)	50.6% (41)	0.144
>= 3	42.9% (102)	39.5% (62)	49.4% (40)	
Mean ASA Score	2.4 ± 0.5	2.4 ± 0.5	2.5 ± 0.5	0.145
Insurance				
Medicare/Medicaid	18.1% (43)	20.4% (32)	13.6% (11)	
Workers' Compensation	29.8% (71)	28.7% (45)	32.1% (26)	0.428
Private	52.1% (124)	51.0% (80)	54.3% (44)	

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

Table 2. Perioperative Characteristics -MATCHED

	Total (n=238)	Non-Diabetic (n=157)	Diabetic (n=81)	*p-value
Spinal Pathology				
Central Stenosis	89.1% (212)	89.8% (141)	87.7% (71)	0.614
Foraminal Stenosis	38.7% (73)	28.9% (47)	32.1% (26)	0.732
Degenerative Spondylolisthesis	49.6% (118)	47.8% (75)	53.1% (43)	0.437
Isthmic Spondylolisthesis	21.4% (51)	24.2% (38)	16.1% (13)	0.146
Recurrent Herniated Nucleus Pulposus	13.0% (31)	11.5% (18)	16.1% (13)	0.319
Degenerative Scoliosis	13.9% (33)	14.7% (23)	12.4% (10)	
Fusion Procedure				0.626
MIS-TLIF (2)	70.2% (167)	69.4% (109)	71.8% (58)	0.673
ALIF (3)	13.5% (32)	12.7% (20)	14.8% (12)	
LLIF (4)	36.6% (87)	37.6% (59)	33.8% (11)	
1-room Level				0.165
L1-L2	0.4% (1)	0.6% (1)	0.0% (0)	
L2-L3	0.4% (1)	0.0% (0)	1.2% (1)	
L2-L3	1.7% (4)	1.9% (3)	1.2% (1)	
L2-L4	1.3% (3)	1.3% (2)	1.2% (1)	
L2-L5	0.8% (2)	1.3% (2)	0.0% (0)	
L3-L4	6.7% (16)	8.9% (14)	2.4% (2)	
L3-L5	4.6% (11)	4.5% (7)	4.9% (4)	
L4-L5	43.9% (104)	40.9% (64)	51.9% (42)	
L5-S1	7.6% (18)	5.1% (8)	11.2% (10)	
L4-S1	31.0% (74)	33.1% (52)	24.7% (20)	
T12-L1	0.4% (1)	0.0% (0)	1.2% (1)	
Number of Levels Operated				0.435
Single Level (0)	89.0% (211)	87.9% (138)	91.3% (73)	
Multiple Levels (1)	11.0% (26)	12.1% (19)	8.8% (7)	
Operative Time (mean ±SD, min)	150.2 ± 71.2	149.3 ± 70.1	151.9 ± 73.6	0.703
Estimated Blood Loss (mean ±SD, mL)	88.0 ± 152.5	87.7 ± 149.0	88.6 ± 116.7	0.966
Length of Stay (mean ±SD, hours)	54.2 ± 28.8	51.6 ± 36.9	59.3 ± 42.2	0.159
Post-operative Day of Discharge (POD)				
POD0	4.4% (10)	4.6% (7)	3.9% (3)	0.315
POD1	38.6% (88)	42.5% (65)	29.9% (23)	
POD2	26.3% (61)	24.2% (37)	31.2% (24)	
POD3	17.4% (40)	16.3% (25)	19.5% (15)	
POD4	6.3% (11)	3.9% (5)	7.8% (6)	
Postoperative VAS Pain Score				
POD0	5.0 ± 1.9	5.2 ± 2.0	4.8 ± 1.8	0.128
POD1	4.6 ± 1.7	4.7 ± 1.8	4.5 ± 1.5	0.614
Postoperative Narcotic Consumption (OME)				
POD0	82.0 ± 61.8	85.6 ± 64.9	75.1 ± 55.2	0.215
POD1	64.1 ± 75.7	65.6 ± 85.1	61.1 ± 53.3	0.668

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 with Student's t-test for continuous variables and chi-square for categorical variables
Boldface indicates statistical significance.

Table 3. Postoperative Complications

Complication	Total (n=238)	Non-Diabetic (n=157)	Diabetic (n=81)	*p-value
Reintubation	0.0% (0)	0.0% (0)	0.0% (0)	-
Urinary Retention	9.2% (22)	8.9% (14)	9.9% (8)	0.809
Urinary Tract Infection	1.3% (3)	1.9% (3)	0.0% (0)	0.211
Acute Renal Failure	1.3% (3)	1.3% (2)	1.2% (1)	0.979
Altered Mental Status	2.9% (7)	1.3% (2)	6.2% (5)	**0.034**
VTE	0.0% (0)	0.0% (0)	0.0% (0)	-
Pulmonary Embolism	0.0% (0)	0.0% (0)	0.0% (0)	-
Pneumothorax	0.0% (0)	0.0% (0)	0.0% (0)	-
Pneumonia	0.4% (1)	0.6% (1)	0.0% (0)	0.472
Atelectasis	0.4% (1)	0.6% (1)	0.0% (0)	0.472
Pleural Effusion	0.0% (0)	0.0% (0)	0.0% (0)	-
Arrhythmia	0.4% (1)	0.0% (0)	1.2% (1)	0.163
Ileus	2.9% (7)	3.2% (5)	2.5% (2)	0.757
Nausea / Vomiting	8.8% (21)	8.9% (14)	8.6% (7)	0.943
Hematoma	0.4% (1)	0.6% (1)	0.0% (0)	0.472
Dysphagia	0.8% (2)	0.6% (1)	1.2% (1)	0.632
Fever of Unknown Origin	15.1% (36)	14.0% (22)	17.3% (14)	0.505

VTE = venous thromboembolism
*p-value calculated with chi-square for categorical variables
Boldface indicates statistical significance.

Table 4. Patient Reported Outcome Measures

	Non-Diabetic Mean ±SD	Non-Diabetic Post-operative PROM Improvement	Diabetic Mean ±SD	Diabetic Post-operative PROM Improvement	*p-value
VAS Back					
Preoperative	6.6 ± 2.4	-	6.4 ± 2.2	-	0.607
6-weeks	3.9 ± 2.8	**<0.001**	4.1 ± 2.3	**<0.001**	0.572
12-weeks	3.5 ± 2.7	**<0.001**	3.9 ± 2.7	**<0.001**	0.364
6-months	3.5 ± 2.8	**<0.001**	3.3 ± 2.3	**<0.001**	0.650
1-year	3.9 ± 2.9	**<0.001**	3.4 ± 3.3	**0.003**	0.560
2-year	4.5 ± 3.1	**0.005**	5.0 ± 3.0	0.281	0.660
VAS Leg					
Preoperative	5.6 ± 2.8	-	5.5 ± 2.6	-	0.817
6-weeks	3.2 ± 3.0	**<0.001**	3.7 ± 2.5	**0.009**	0.409
12-weeks	2.4 ± 2.5	**<0.001**	3.7 ± 3.0	**0.003**	**0.016**
6-months	2.2 ± 2.6	**<0.001**	3.6 ± 3.0	**0.001**	**0.019**
1-year	3.0 ± 3.1	**<0.001**	2.9 ± 3.1	**0.002**	0.936
2-year	4.1 ± 3.2	**0.001**	3.2 ± 3.3	**0.003**	0.450
ODI					
Preoperative	41.6 ± 17.4	-	45.4 ± 17.1	-	0.220
6-weeks	35.6 ± 20.3	**0.013**	41.5 ± 17.9	0.589	0.149
12-weeks	27.3 ± 18.7	**<0.001**	34.2 ± 16.6	**<0.001**	0.066
6-months	23.6 ± 20.0	**<0.001**	26.6 ± 16.4	**<0.001**	0.427
1-year	29.4 ± 22.7	**<0.001**	33.3 ± 25.7	**0.002**	0.541
2-year	32.7 ± 27.2	**0.044**	36.3 ± 20.6	0.165	0.666
SF-12 MCS					
Preoperative	47.5 ± 11.7	-	47.4 ± 13.6	-	0.981
6-weeks	51.3 ± 12.1	**<0.001**	50.2 ± 15.3	0.204	0.710
12-weeks	53.4 ± 11.4	**<0.001**	51.9 ± 14.1	**0.009**	0.612
6-months	53.0 ± 10.8	**<0.001**	51.1 ± 12.3	**0.049**	0.509
1-year	51.9 ± 10.3	**0.001**	49.8 ± 12.9	**0.004**	0.455
2-year	50.5 ± 11.8	0.709	54.1 ± 11.7	0.987	0.428
SF-12 PCS					
Preoperative	31.0 ± 8.0	-	28.3 ± 6.6	-	0.072
6-weeks	31.5 ± 8.5	0.787	28.8 ± 8.0	0.904	0.166
12-weeks	36.4 ± 9.1	**<0.001**	29.2 ± 8.3	0.388	**<0.001**
6-months	38.7 ± 11.3	**<0.001**	35.2 ± 11.3	**<0.001**	0.226
1-year	38.5 ± 12.1	**<0.001**	35.5 ± 9.6	**0.002**	0.303
2-year	38.9 ± 13.1	**0.001**	36.9 ± 11.0	**0.002**	0.684

*p-value calculated using Student's t-test between groups
Boldface indicates statistical significance.

Table 5. MCID Achievement

	Non-Diabetic	Diabetic	*p-value
VAS Back			
6-weeks	55.7%	47.0%	0.241
12-weeks	60.8%	52.2%	0.243
6-months	58.8%	57.8%	0.887
1-year	43.6%	41.2%	0.867
2-year	40.0%	42.9%	0.862
Overall	72.6% (111)	70.0% (56)	0.682
VAS Leg			
6-weeks	45.6%	34.4%	0.280
12-weeks	56.8%	43.8%	0.218
6-months	59.7%	45.5%	0.172
1-year	51.3%	41.2%	0.487
2-year	47.6%	69.2%	0.217
Overall	61.1% (55)	66.7% (28)	0.538
ODI			
6-weeks	29.3%	21.9%	0.425
12-weeks	41.3%	29.4%	0.234
6-months	60.5%	54.1%	0.512
1-year	47.5%	37.5%	0.496
2-year	45.5%	38.5%	0.686
Overall	65.6% (61)	59.1% (26)	0.461
SF-12 MCS			
6-weeks	27.6%	21.4%	0.540
12-weeks	32.1%	23.1%	0.401
6-months	34.0%	34.8%	0.948
1-year	36.6%	31.6%	0.705
2-year	15.6%	0.0%	0.232
Overall	49.3% (37)	44.4% (16)	0.629
SF-12 PCS			
6-weeks	40.4%	39.3%	0.925
12-weeks	63.6%	57.7%	0.607
6-months	64.0%	69.6%	0.642
1-year	68.3%	68.4%	0.992
2-year	65.6%	87.5%	0.227
Overall	78.4% (58)	83.3% (30)	0.542

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