Predictors of Non-improvement After Minimally Invasive Lumbar Spine Surgery

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INTRODUCTION:

In general, minimally invasive spine (MIS) surgery is associated with overwhelmingly positive clinical outcomes**.** However, as with all surgical procedures, there can be some degree of variability in patient outcomes, with a small subset of patients whose symptoms unfortunately may not improve, or even worsen, after surgery. Although prior studies have evaluated predictors of best outcomes or specific complications following MIS spine surgery, there is a paucity of data investigating predictors of non-improvement in this population. Therefore, the objective of this study was to identify the predictors of non-improvement following MIS lumbar spine surgery.

METHODS:

Patients who underwent MIS transforaminal interbody fusion (TLIF), laminectomy, or microdiscectomy at a single institution between 2017-2021 were included. Patients with less than 6 months of follow-up or missing preoperative PROMs data were excluded. Patients were grouped into 3 cohorts based on GRC at long-term follow-up – better, same, or worse after surgery. For regression analysis, the GRC variable was binarized into improvement (better) vs. non-improvement (same or worse). Multivariate regression models were utilized to identify the risk factors for non-improvement.

RESULTS:

The total cohort included 448 patients. 191 patients underwent TLIF, 129 patients underwent laminectomy, and 128 patients underwent microdiscectomy. A total of 66 patients (14.7%) reported no significant improvement at long-term follow-up; among these, 35 patients (7.8%) reported worsening after surgery, while 31 patients (6.9%) reported no change. Patients who worsened after surgery were older on average compared to patients who improved after surgery. Obesity was more common among patients with no change at LTFU compared to those who improved. There were no differences in GRC among types of surgery or number of surgical levels. There were no differences in any preoperative PROMs scores based on GRC cohorts.

Multivariate regression analysis identified older age, obesity, and smoking as independent risk factors for non-improvement after MIS lumbar spine surgery. Sex, education level, employment, Charlson Comorbidity Index, anxiety, and depression did not independently predict non-improvement after surgery. In addition, type of surgery, number of surgical levels, and preoperative PROM scores also did not predict non-improvement.

DISCUSSION AND CONCLUSION:

Our results suggest that older age, obesity, and smoking independently predict non-improvement after MIS lumbar spine surgery. Prior studies have reported on poorer clinical outcomes among elderly patients undergoing spine surgery. The etiology of the negative effect of older age on chance of improvement after surgery is likely multifactorial, with some potential factors including worse bone health, worse muscle health, greater degeneration at non-operative levels, and greater coronal and sagittal malalignment.

The association between obesity and poorer outcomes found in the present study is consistent with prior literature. Patel et al. demonstrated that among patients undergoing MIS lumbar decompression for herniated nucleus pulposus, obesity predicted longer length of stay and delayed disability relief. Contrastingly, there have also been data suggesting that obesity has no significant influence on outcomes following surgical treatment of lumbar degenerative disorders. Given the discordance that is present in literature, further investigations evaluating the impact of obesity on outcomes following specific types of lumbar spine surgery are warranted.

The results of our study indicated that smoking is an independent predictor of non-improvement after MIS lumbar spine surgery. Changes in metabolic systems and local vasculature have been implicated as the reason for wide-ranging effects of smoking in spine surgery. Notably, the majority of studies have found that smoking status has the greatest impact on fusion patients, as it is associated with poor fusion and increased risk of postoperative complications.

In conclusion, the current study revealed a 14.7% rate of non-improvement among patients undergoing MIS lumbar spine surgery. We identified older age, obesity, and smoking to be independent predictors of non-improvement after MIS lumbar spine surgery based on the Global Rating of Change scale. This study provides valuable evidence that may be utilized to improve patient selection and establish clearer patient expectations for those undergoing MIS lumbar spine surgery.

Table 1. Baseline Patient Demographics and Comorbidities

	Global Ratings Change			
	Better	**Same**	**Worse**	***p*-value**
N of subjects	382	31	35	
Demographics				
Age (years)	56.8±15.1[a]	61.4±16.2	63.7±15.5[a]	**0.014**
Male sex	217 (56.8%)	16 (51.6%)	26 (74.3%)	0.103
Non-white race	53 (13.9%)	3 (9.7%)	8 (22.9%)	0.260
Hispanic ethnicity	32 (8.4%)	4 (12.9%)	3 (8.6%)	0.691
BMI (kg/m²)	26.8±5.1	28.4±6.0	28.2±5.4	0.069
Obesity (BMI ≥30)	73 (19.1%)[a]	13 (41.9%)[a]	10 (28.6%)	**0.007**
Workers' compensation	6 (1.6%)	0	0	0.591
Education level less than 4-year college	65 (17.0%)	10 (32.3%)	6 (17.1%)	0.104
Employment				
Unemployed	32 (8.4%)	2 (6.5%)	4 (11.4%)	0.755
Sedentary occupation	90 (23.6%)	5 (16.1%)	10 (28.6%)	0.487
Comorbidities				
CCI ≥1	268 (70.2%)	23 (74.2%)	31 (88.6%)	0.065
Smoking	10 (2.6%)	2 (6.5%)	3 (8.6%)	0.106
Depression/anxiety	76 (19.9%)	10 (32.3%)	6 (17.1%)	0.228
ASA class ≥3	16 (4.2%)	2 (6.5%)	4 (11.4%)	0.152

Bold values indicate statistical significance (*p*<0.05). Superscripts denote statistically significant pairwise post-hoc analysis with Bonferroni correction. BMI, body mass index; CCI, Charlson Comorbidity Index; ASA, American Society of Anesthesiologists.

Table 2. Types of Surgery Performed

	Global Ratings Change			
	Better	**Same**	**Worse**	***p*-value**
TLIF	164 (85.9%)	13 (6.8%)	14 (7.3%)	0.942
Single-level	121 (73.8%)	7 (53.8%)	12 (85.7%)	0.162
Multi-level	43 (26.2%)	6 (46.2%)	2 (14.3%)	
Laminectomy	103 (79.8%)	11 (8.5%)	15 (11.6%)	0.153
Single level	70 (68.0%)	8 (72.7%)	12 (80.0%)	0.622
Multi-level	33 (32.0%)	3 (27.3%)	3 (20.0%)	
Microdiscectomy	115 (89.8%)	7 (5.5%)	6 (4.7%)	0.199
Single level	112 (97.4%)	7 (100.0%)	6 (100.0%)	0.841
Multi-level	3 (2.6%)	0	0	

TLIF, transforaminal lumbar interbody fusion.

Table 3. Preoperative Patient-Reported Outcome Measure Scores

	Global Ratings Change			
	Better	**Same**	**Worse**	***p*-value**
N of subjects	382	31	35	
ODI	37.7±18.7	42.9±17.2	35.3±17.8	0.241
VAS Back	4.9±3.1	5.5±2.7	4.9±2.6	0.565
VAS Leg	5.6±3.1	6.2±2.5	4.7±3.0	0.111
SF-12 MCS	48.0±11.2	46.1±11.4	50.3±13.4	0.337
SF-12 PCS	33.3±8.8	30.3±8.1	32.9±9.5	0.184

ODI, Oswestry Disability Index; VAS, Visual Analog Scale; SF-12, Short Form 12; MCS, Mental Component Score; PCS, Physical Component Score.

Table 4. Multivariate logistic regression of risk factors for non-improvement after MIS lumbar spine surgery

	Odds Ratio	**95% Confidence Interval**	***p*-value**
Demographics			
Age	1.030	1.006 - 1.055	**0.015**
Male sex	1.388	0.769 - 2.503	0.276
Obesity	2.416	1.307 - 4.469	**0.005**
Education level less than 4-year college	1.702	0.870 - 3.329	0.120
Comorbidities			
CCI ≥1	1.176	0.396 - 3.489	0.771
Smoking	3.669	1.141 - 11.799	**0.029**
ASA class ≥3	1.825	0.616 - 5.412	0.278
Type of Surgery			
TLIF	0.941	0.527 - 1.680	0.837
Laminectomy	1.488	0.692 - 3.198	0.309
Microdiscectomy	0.784	0.384 - 1.601	0.503
Preoperative PROMs			
ODI	1.002	0.978 - 1.027	0.855
VAS Back	1.050	0.938 - 1.176	0.396
VAS Leg	0.924	0.831 - 1.029	0.150
SF-12 MCS	1.000	0.970 - 1.031	0.996
SF-12 PCS	0.984	0.941 - 1.030	0.500

Bold values indicate statistical significance (*p*<0.05). CCI, Charlson Comorbidity Index; ASA, American Society of Anesthesiologists; ODI, Oswestry Disability Index; VAS, Visual Analog Scale; SF-12, Short Form 12; MCS, Mental Component Score; PCS, Physical Component Score.