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Oral Presentation at 63rd Western Neurosurgical Society Meeting, Banff, Alberta, Canada, September 10, 2017; Oral Presentation at 24th International Meeting on Advanced Spine Techniques (sponsored by the Scoliosis Research Society), Cape Town, South Africa, July 14, 2017; Poster Presentation at 2017 Congress of Neurological Surgeons Annual Meeting, Boston, Massachusetts, October 7 to 11, 2017. Oral Presentation at 34th Annual Meeting of the Section on Disorders of the Spine and Peripheral Nerves, Orlando, Florida, March 16, 2018. Oral Presentation at 11th Annual Lumbar Spine Research Society Meeting, Chicago, Illinois, April 5 to 6, 2018.

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Received, June 8, 2018.
Accepted, November 5, 2018.
Published Online, December 12, 2018.

Obese Patients Benefit, but do not Fare as Well as Nonobese Patients, Following Lumbar Spondylolisthesis Surgery: An Analysis of the Quality Outcomes Database

BACKGROUND: Given recent differing findings following 2 randomized clinical trials on degenerative lumbar spondylolisthesis (DLS) surgery, there is a need to better define how subsets of patients fare following surgery.

OBJECTIVE: To investigate the impact of obesity on patient-reported outcomes (PROs) following DLS surgery.

METHODS: A total of 12 high-enrolling sites were queried, and we found 797 patients undergoing surgery for grade 1 DLS. For univariate comparisons, patients were stratified by BMI ≥ 30 kg/m^2 (obese) and < 30 kg/m^2 (nonobese). Baseline, 3-mo, and 12-mo follow-up parameters were collected. PROs included the North American Spine Society satisfaction questionnaire, numeric rating scale (NRS) back pain, NRS leg pain, Oswestry Disability Index (ODI), and EuroQoL-5D (EQ-5D) Questionnaire.

RESULTS: We identified 382 obese (47.9%) and 415 nonobese patients (52.1%). At baseline, obese patients had worse NRS back pain, NRS leg pain, ODI, and EQ-5D scores ($P < .001$, $P = .01$, $P < .001$, and $P = .02$, respectively). Both cohorts improved significantly for back and leg pain, ODI, and EQ-5D at 12 mo ($P < .001$). At 12 mo, similar proportions of obese and nonobese patients responded that surgery met their expectations (62.6% vs 67.4%, $P = .24$). In multivariate analyses, BMI was independently associated with worse NRS leg pain and EQ-5D at 12 mo ($P = .01$ and $P < .01$, respectively) despite adjusting for baseline differences.

CONCLUSION: Obesity is associated with inferior leg pain and quality of life—but similar back pain, disability, and satisfaction—12 mo postoperatively. However, obese patients achieve significant improvements in all PRO metrics at 12 mo.

KEY WORDS: Lumbar, Spondylolisthesis, Obesity, Quality Outcomes Database, Patient-reported outcomes

Neurosurgery 86:80–87, 2020 DOI:10.1093/neuros/nyy589 www.neurosurgery-online.com

With a prevalence of 11.5% in the United States,[1] degenerative lumbar spondylolisthesis is a major cause of back pain. For a subset of patients who fail conservative management strategies, surgery is considered.[2-6] Two recent randomized clinical trials arrived at differing conclusions regarding the benefit of the addition of fusion to decompressive surgery for degenerative lumbar spondylolisthesis.[7,8] These discrepant results have attracted the attention of multiple stakeholders—including physicians, administrators, payers, and patients—to identify factors that optimize outcomes after lumbar spondylolisthesis surgery. Namely, the identification of populations that may fare the best or worst after surgery is important for resource allocation.

ABBREVIATIONS: ASA, American Society of Anesthesiologists; **BMI,** body mass index; **EQ-5D,** EuroQol-5D; **MIS,** minimally invasive; **NASS,** North American Spine Society; **NRS,** Numeric Rating Scale; **ODI,** Oswestry Disability Index; **OR,** odds ratio; **PROs,** patient-reported outcomes; **QOD,** Quality Outcomes Database; **SF-36,** Short Form 36; **SPORT,** Spine Patient Outcomes Research Trial

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According to the National Health and Nutrition Examination Survey, one-third of adults 20 yr and older are obese in the United States.[9] Obesity and its metabolic derangements are associated with back pain, sciatica, and disc degeneration.[10-13] For a variety of spinal pathology, obesity has been linked to worse baseline pain, disability, quality of life, functional status, and worse perioperative outcomes and complication rates following operative treatment.[14-24] However, this inferiority is not consistent, as obese patients have been shown to be able to attain equivalent patient-reported outcomes (PROs) following surgery.[15-17,22]

The specific effect of obesity on degenerative lumbar spondylolisthesis surgery remains unclear. In a subgroup analysis of the Spine Patient Outcomes Research Trial (SPORT), aside from less improvement in Short Form 36 (SF-36) physical function scores, there were no significant differences for obese patients in outcomes 4 yr following spondylolisthesis surgery.[15] However, in a separate large, prospective spine registry, obese patients had worse pain, disability, and quality of life 2 yr following surgery,[18] though this cohort included patients with lumbar stenosis in general. Further study is required to clarify the impact of obesity on lumbar spondylolisthesis surgery.

To this end, we analyzed the prospective, multicenter, and multidisciplinary Quality Outcomes Database (QOD) to compare the initial 12-mo outcomes for 797 obese and nonobese patients undergoing surgery for grade 1 degenerative lumbar spondylolisthesis.

METHODS

The prospective spine surgery QOD registry includes demographic, clinical, and PRO data[25] on over 12 000 patients across 80 participating orthopedic and neurosurgical centers nationwide. Twelve, high-enrolling sites participate in a lumbar spondylolisthesis module.[26-28] We queried the module from July 2014 to December 2015 for patients undergoing surgery for grade 1 lumbar spondylolisthesis. Preoperative plain films (standing or dynamic) were obtained and were evaluated by surgeons at the participating sites to confirm the diagnosis of Meyerding[29] grade 1 spondylolisthesis. Patients were excluded who had grade II or higher spondylolisthesis. Informed consent and institutional review board approval were obtained (University of Utah IRB# 00092536).

Baseline and Surgical Variables

As published previously,[26-28] we collected demographic variables (age, sex, body mass index [BMI], ethnicity, insurance, education level, employment), patient comorbidities (smoking, diabetes, anxiety, osteoporosis, depression, American Society of Anesthesiologists [ASA] classification), clinical characteristics (dominant presenting symptom, ambulation status, presence of motor deficit), baseline PRO scores (Oswestry Disability Index [ODI], EuroQol-5D [EQ-5D], Numeric Rating Scale [NRS] leg pain, NRS back pain, North American Spine Society [NASS] satisfaction questionnaire), and surgical variables (type of approach, use of minimally invasive [MIS] techniques, performance of a laminectomy, whether a fusion was performed, estimated blood loss, operative time, length of hospitalization, and discharge disposition).

Ethnicity (Hispanic or Latino versus Not Hispanic or Latino), insurance status (private insurance vs Medicare, Medicaid, or VA/government), education level (4-yr degree post high school education or greater vs less than a 4-yr degree post high school education), employment status (employed or on leave vs unemployed), ambulation status (independently ambulatory vs nonindependently ambulatory [eg, with an assistive device]), and discharge disposition (discharged to home or home health care vs discharge not to home or home health care) were 2-level variables. Dominant presenting symptom was a 3-level variable (back pain predominant, leg pain predominant, or back pain = leg pain).

Surgical approaches included posterior only, anterior only, lateral only, and those who underwent a staged approach. Surgeries were categorized as utilizing MIS techniques if any of the following were involved: MIS laminectomy, MIS pedicle screws, MIS interbody, cortical screws, or percutaneous screws.

Study Outcomes

We assessed outcomes at 3 and 12 mo using validated questionnaires: ODI, NRS back pain, NRS leg pain, EQ-5D, and NASS satisfaction score. Secondary outcomes included 90-d readmissions and 12-mo reoperations. Readmissions and reoperations were recorded that were deemed related to surgery by study site coordinators.

The NASS satisfaction questionnaire gauges postoperative satisfaction via 4 responses scored 1 through 4, respectively: surgery met my expectations, I did not improve as much as I had hoped but I would undergo the same operation for the same results, surgery helped but I would not undergo the same operation for the same results, I am the same or worse as compared to before surgery.

Statistical Analysis

Means and standard deviations and frequencies and percentages were reported where appropriate. Variables were compared using rank sum tests (continuous variables) and Pearson's Chi-square test and Yates' correction for continuity where appropriate (categorical variables) via custom and built-in scripts (Matlab, Mathworks, Natick, Massachusetts). For univariate comparisons, patients were stratified by BMI $\geq$ 30 kg/m^2 (obese) and <30 kg/m^2 (nonobese). For multivariate analyses, obesity was captured as BMI, a continuous variable. Multivariate linear regression models were fitted for ODI, EQ-5D, NRS back pain, and NRS leg pain. For each model, covariates included (1) each respective baseline PRO value and (2) any baseline factor that reached $P < .20$ on univariate analysis. An ordinal logistic regression model was fit for NASS satisfaction questionnaire score after controlling for covariates of interest. Covariates included the 4 respective baseline PRO values and the additional factors that reached $P < .20$ on univariate analysis. This analysis was conducted using R 2.15.2 (R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria). Missing values in the data were imputed using the "missForest" R package.[30] P-values were 2-tailed and an alpha of .05 was considered statistically significant.

RESULTS

Patient Characteristics

From July 1, 2014 to December 31, 2015, there were 797 patients who underwent surgery for grade 1 lumbar

TABLE 1. Characteristics of Obese and Nonobese Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	Obese n = 382	Nonobese n = 415	*P* value
Age (yr)	60.7 ± 11.3	64.1 ± 11.9	<.001 **
Female	218 (57.1%)	231 (55.7%)	.69
BMI	35.7 ± 4.9	25.9 ± 2.7	<.001**
Smoker	29 (7.6%)	57 (13.7%)	.01 **
Comorbidities			
Diabetes mellitus	94 (24.6%)	45 (10.8%)	<.001**
Coronary artery disease	49 (12.8%)	40 (9.6%)	.15
Anxiety	76 (19.9%)	67 (16.1%)	.17
Depression	86 (22.5%)	77 (18.6%)	.17
Osteoporosis	21 (5.5%)	30 (7.2%)	.32
Dominant presenting symptom			<.01 **
Back pain predominant	152 (39.8%)	163 (39.3%)	
Leg pain predominant	60 (15.7%)	101 (24.3%)	
Back = leg pain	170 (44.5%)	151 (36.4%)	
Presence of a motor deficit	77 (20.2%)	104 (25.1%)	.10
Independently ambulatory at presentation	321 (84.0%)	377 (90.8%)	<.01**
ASA grade			<.001**
1 or 2	167 (43.7%)	271 (65.3%)	
3 or 4	203 (53.1%)	126 (30.4%)	
Type of insurance			.38
Private	208 (54.5%)	213 (51.3%)	
Nonprivate (Medicare, Medicaid, or VA/government)	174 (45.5%)	202 (48.7%)	
Ethnicity			.79
Hispanic or Latino	19 (5.0%)	19 (4.6%)	
Not Hispanic or Latino	363 (95.0%)	396 (95.4%)	
Level of education			.07
Four year degree or more	129 (33.8%)	166 (40.0%)	
Less than a 4 yr degree	253 (92.1%)	249 (60.0%)	
Employment status			.85
Employed or on leave	165 (43.2%)	182 (43.9%)	
Not employed	217 (56.8%)	233 (56.1%)	
PROs			
NRS back pain, baseline	7.2 ± 2.4	6.4 ± 2.9	<.001**
NRS leg pain, baseline	6.9 ± 2.7	6.3 ± 2.9	.01 **
ODI, baseline	48.2 ± 17.1	43.8 ± 17.7	<.001**
EQ-5D, baseline	0.52 ± 0.22	0.56 ± 0.22	.01**

BMI, body mass index; ASA, American Society of Anesthesiologists; VA, Veterans Affairs; NRS, Numerical Rating Scale; ODI, Oswestry Disability Index; EQ-5D, EuroQol-5D
Percentages do not add up to 100% where a response was not recorded.
**Denotes a statistically significant relationship, alpha level .05.

spondylolisthesis. This included 382 (47.9%) obese patients and 415 (52.1%) nonobese patients. Descriptive variables are presented in Table 1.

At baseline, the obese cohort was younger (60.7 ± 11.3 vs 64.1 ± 11.9 yr, $P < .001$), had higher ASA grades (53.1% vs 30.4% ASA 3 or 4, $P < .001$), a greater proportion with diabetes mellitus (24.6% vs 10.8%, $P < .001$), and had a different distribution of presenting symptoms ($P < .01$) with a greater proportion presenting with back pain complaints (ie, back pain predominant and back pain = leg pain). The obese cohort had fewer patients who were independently ambulatory at presentation (84.0% vs 90.8%, $P < .01$). At baseline, the obese cohort had inferior NRS back pain (7.2 ± 2.4 vs 6.4 ± 2.9, $P < .001$), NRS leg pain (6.9 ± 2.7 vs 6.3 ± 2.9, $P = .01$), disability (ODI 48.2 ± 17.1 vs 43.8 ± 17.7, $P < .001$), and EQ-5D (0.52 ± 0.22 vs 0.56 ± 0.22, $P = .02$).

Surgical Variables and Perioperative Outcomes

Table 2 demonstrates the surgical variables including perioperative outcomes. There was a greater number of patients who received a fusion in the obese cohort (85.1% vs 75.4%, $P < .001$). There were no significant differences in surgical

TABLE 2. Surgical Variables for Obese and Nonobese Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	Obese n = 382	Nonobese n = 415	P value
Approach			.80
Posterior only	347 (90.8%)	378 (91.1%)	
Anterior only	13 (3.4%)	10 (2.4%)	
Lateral only	5 (1.3%)	5 (1.2%)	
2-Stage approach	17 (4.5%)	22 (5.3%)	
MIS Surgery	143 (37.4%)	175 (42.2%)	.17
Laminectomy performed	337 (88.2%)	377 (90.8%)	.23
Fusion performed	325 (85.1%)	313 (75.4%)	<.001**
Estimated blood loss (ml)	272.9 ± 311.4	203.1 ± 227.5	<.001**
Operative time (min)	203.4 ± 93.1	177.4 ± 86.7	<.001**
Length of hospitalization (d)	3.2 ± 1.7	2.7 ± 1.9	<.001**
Discharge disposition			
Home or home health care	324 (84.8%)	381 (91.8%)	<.01 **
Not to home or home health care	58 (15.2%)	34 (8.2%)	

**Denotes a statistically significant relationship, alpha level .05.

approach ($P = .80$), whether an MIS technique was utilized ($P = .17$), and whether a laminectomy was performed ($P = .23$). Obesity was associated with inferior perioperative outcomes. The obese cohort had higher blood loss (mean 272.9 ± 311.4 vs 203.1 ± 227.5 mL, $P < .001$), longer operative times (mean 203.4 ± 93.1 vs 177.4 ± 86.7 min, $P < .001$), longer hospitalizations (mean 3.2 ± 1.7 vs 2.7 ± 1.9 d, $P < .001$), and fewer routine discharges (84.8% vs 91.8% discharged to home or home health care, $P < .01$). There were no deaths.

Readmission, Reoperation, and PROs

A total of 19 (5.0%) obese patients and 14 (3.4%) nonobese patients required a readmission within 3 mo. A total of 22 (5.8%) obese patients and 19 (4.6%) nonobese patients required a reoperation within the initial 12-mo follow-up. There were no significant differences between 3-mo readmission and 12-mo reoperation rates ($P = .26$ and $P = .45$, respectively).

Though obese patients had worse mean NRS back pain at baseline, there were no significant differences at 3 mo (3.3 ± 2.6 vs 3.0 ± 2.7, $P = .45$). At 12 mo, however, obese patients had worse mean NRS back pain scores (3.4 ± 2.9 vs 2.7 ± 2.7, $P = .02$). Both cohorts significantly improved from baseline at 3 and 12-mo follow-up ($P < .001$). Figure A demonstrates the trend of NRS back pain score by obesity status over the study period. Mean 12-mo change scores (ie, mean 12-mo NRS back pain score—baseline NRS back pain score) for NRS back pain were not significantly different between obese and nonobese cohorts (mean change –3.7 ± 3.2 vs –3.5 ± 3.2, $P = .98$).

Obese patients had worse NRS leg pain baseline, 3 mo (2.9 ± 3.1 vs 1.9 ± 2.7, $P < .01$) and 12 mo (3.0 ± 3.2 vs 2.0 ± 2.8, $P < .01$). Both cohorts improved from baseline at 3 and 12-mo follow-up ($P < .001$). Figure B demonstrates the trend of NRS leg pain score by obesity status over the study period. Mean 12-mo change scores for NRS leg were not significantly different between obese and nonobese cohorts (mean change –3.7 ± 3.9 vs –4.3 ± 3.6, $P = .14$).

Obese patients had worse disability at baseline—a trend that continued at 3 mo (29.4 ± 19.5 vs 24.5 ± 19.0, $P = .03$) and 12 mo (25.9 ± 20.5 vs 19.0 ± 18.4, $P < .01$). Both cohorts improved from baseline at 3 and 12-mo follow-up ($P < .001$). Figure C demonstrates the trend of ODI score by obesity status over the study period. Mean 12-mo change scores for ODI revealed no significant difference between obese and nonobese cohorts (mean change –21.5 ± 19.3 vs –23.9 ± 19.6, $P = .17$).

Obese patients had worse EQ-5D scores at baseline, 3 mo (0.72 ± 0.21 vs 0.78 ± 0.17, $P < .001$), and 12 mo (0.75 ± 0.21 vs 0.80 ± 0.18, $P = .03$). Both cohorts improved from baseline at 3 and 12-mo follow-up ($P < .001$). Figure D demonstrates the trend of EQ-5D score by obesity status over the study period. Mean 12-mo change scores for EQ-5D revealed no significant difference between obese and nonobese cohorts (mean change + 0.21 ± 0.24 vs + 0.23 ± 0.24, $P = .46$).

At 12 mo, 181 (62.6%) of obese patients found surgery to have met their expectations. Sixty-one (21.1%) found that surgery resulted in less improvement than they had hoped for, but would undergo the same procedure again. Twenty (6.9%) found that surgery did help to some extent, but they would not undergo the procedure again for the same result. Twenty-seven (9.3%) responded that they felt the same or worse as they had before surgery. These responses were not significantly different than responses of the nonobese patients (209 (67.4%), 52 (16.8%), 31 (10.0%), and 18 (5.8%), respectively, $P = .10$). There were no significant differences in the distribution of NASS satisfaction questionnaire scores at 3 mo ($P = .31$).

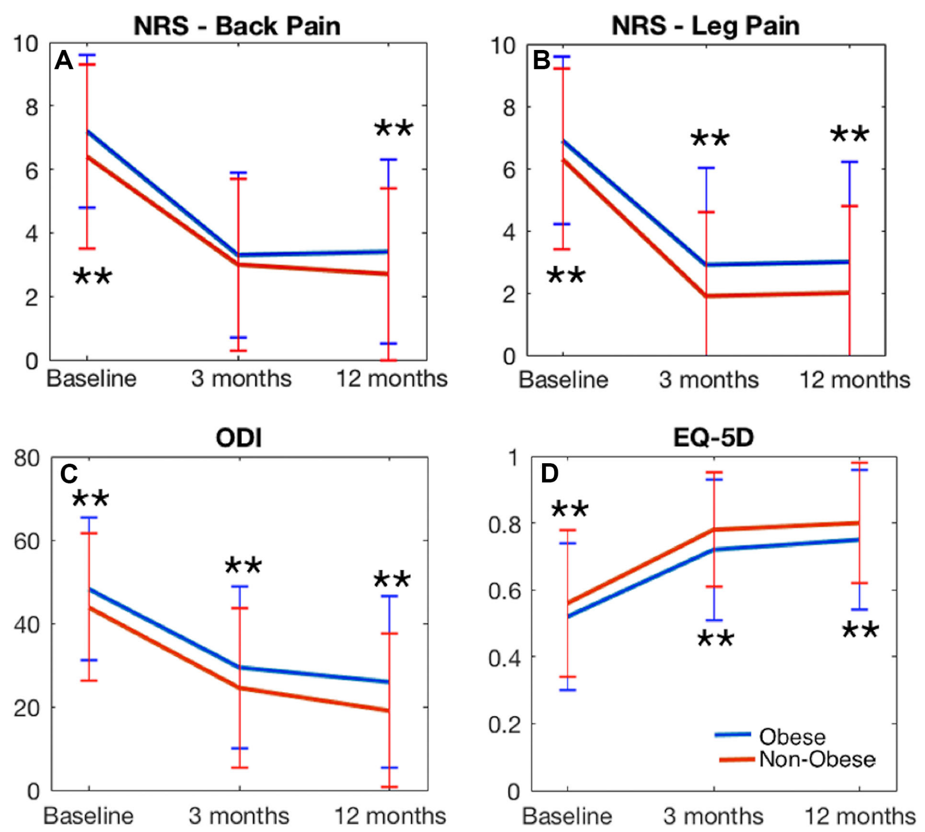

FIGURE. *Baseline, 3-mo, and 12-mo PROs following surgery for grade 1 lumbar spondylolisthesis.* **A**, *Average NRS back pain scores at baseline, 3 mo, and 12 mo following surgery by cohort.* **B**, *Average NRS leg pain scores at baseline, 3 mo, and 12 mo following surgery by cohort.* **C**, *Average ODI at baseline, 3 mo, and 12 mo following surgery by cohort.* **D**, *Average EQ-5D at baseline, 3 mo, and 12 mo following surgery by cohort. The error bars represent one standard deviation. For both cohorts, there were statistically significant improvements at 3 and 12-mo follow-up, relative to baseline, for NRS back and leg pain, ODI, and EQ-5D ($P < .001$, all comparisons). At baseline, the obese cohort had significantly worse NRS back pain ($P < .001$), NRS leg pain ($P = .01$), ODI ($P < .001$), and EQ-5D ($P = .01$). The obese cohort had significantly worse NRS leg pain ($P < .01$), ODI ($P = .03$), and EQ-5D ($P < .001$) at 3 mo. The obese cohort had significantly worse NRS back pain ($P = .02$), NRS leg pain ($P < .01$), ODI ($P < .01$), and EQ-5D ($P = .03$) at 12 mo. There were no significant between-group differences with regards to NRS back pain at 3 mo.*

Multivariate Analysis

In adjusted multivariate analysis (Table 3), BMI was independently associated with worse NRS leg pain and EQ-5D at the initial 12-mo follow-up period (β Coefficient (β) 0.04, $P = .01$ and β −0.004 ($P < .01$), respectively). There was no significant association between BMI and NRS back pain ($P = .12$), BMI and ODI ($P = .41$), and BMI and NASS Satisfaction Score ($P = .41$).

DISCUSSION

In an analysis of 797 patients undergoing surgery for grade 1 degenerative lumbar spondylolisthesis, obesity is associated with inferior perioperative outcomes for blood loss, operative time, length of hospital stay, and discharge disposition. Obesity is associated with worse back pain, leg pain, disability, and quality of life at 12-mo following surgery though—as with the nonobese cohort—obese patients achieved significant improvements in all domains at 12-mo compared to baseline. Obesity is associated with similar satisfaction at 12 mo. In multivariate analysis, obesity is independently associated with worse leg pain and quality of life at 12 mo.

For a variety of spinal pathology, obesity is associated with inferior perioperative outcomes following surgery.[22,23,31-33] Our study extends this finding to perioperative outcomes following

TABLE 3. Multivariate Analysis Assessing the Effect of BMI on PROs Following Surgery for Grade 1 Lumbar Spondylolisthesis

	Adjusted[1] β Coefficient (95% CI)	*P* value
NRS back pain	0.03 (−0.01–0.06)	.12
NRS leg pain	0.04 (0.01–0.08)	.01**
ODI	– 0.21 (−0.72–0.30)	.41
EQ-5D	– 0.004 (−0.006–0.001)	<.01**
	Adjusted[1] Odds Ratio (95% CI)	
NASS satisfaction questionnaire score	1.01 (0.99-1.04)	.41

BMI, body mass index; NRS, Numerical Rating Scale; ODI, Oswestry Disability Index; EQ-5D, EuroQol-5D; NASS, North American Spine Society
[1]Covariates adjusted for included respective baseline NRS back pain, NRS leg pain, ODI, or EQ-5D value and age, smoking status, comorbidities (diabetes mellitus, coronary artery disease, anxiety, depression), dominant presenting symptom, presence of motor deficit on presentation, ability to ambulate independently on admission, level of education, ASA grade, whether an MIS technique was utilized, whether a fusion was utilized, estimated blood loss, operative time, length of stay, and discharge disposition.
**Denotes a statistically significant relationship, alpha level .05.

degenerative lumbar spondylolisthesis. This is largely consistent with the 2 subgroup analyses of the SPORT trial, which investigated the impact of obesity[15] and high obesity[16] on degenerative lumbar spondylolisthesis. As in the present study, obesity was associated with inferior perioperative outcomes for operative time and increased length of hospitalization. This may be related to the higher proportion of obese patients undergoing fusion procedures, which are associated with longer operative times and higher blood loss.[7,8]

Prior studies have shown a higher reoperation rate in obese patients undergoing surgery for degenerative lumbar spondylolisthesis.[15,16] We did not find a higher rate in the QOD cohort. However, our study is limited in its 12-mo follow-up (vs 4-yr follow-up by Rihn et al). Given that only a small proportion of reoperations occur within 1 yr following degenerative lumbar spondylolisthesis surgery,[7] this result is not surprising. Longer follow-up is required to determine the durability of surgery for obese patients.

As for PROs, the QOD registry finds inferior 12-mo outcomes for leg pain and EQ-5D in the obese cohort, even when adjusting for potential confounding variables including whether or not the patient received a fusion procedure. However, obesity was not associated with inferior outcomes for back pain, ODI, and satisfaction. The prior literature shows a similarly variable impact of obesity on degenerative lumbar spondylolisthesis surgery. The initial SPORT subgroup analysis by Rihn et al studied the impact of obesity (BMI $\geq$ 30 kg/m^2) on the primary outcomes of SF-36 bodily pain, SF-36 physical function, and ODI following surgery for degenerative lumbar spondylolisthesis.[15] They did not find significant differences for SF-36 bodily pain and ODI, but did find worse outcomes at 12 mo for SF-36 physical function in adjusted analyses. These findings remained in extended 4-yr follow-up. This association of obesity with worse SF-36 physical function was corroborated in further SPORT subgroup analysis of the most obese patients undergoing degenerative lumbar spondylolisthesis surgery.[16]

Of note, prior analyses investigating the effect of obesity on outcomes following degenerative lumbar spondylolisthesis surgery typically dichotomize obesity by BMI with values $\geq$30 kg/m^2 representing obesity and <30 kg/m^2 representing nonobese patients.[15] Other studies add additional categories for BMI $\geq$ 35 kg/m^2 (obesity class II) or BMI $\geq$ 40 kg/m^2 (obesity class III) following cutoffs established by the World Health Organization.[16,34] As opposed to comparing obese and nonobese cohorts with a somewhat arbitrary classification cutoff, we have shown that for increasing severity of obesity—via analysis of the continuous variable BMI—outcomes are progressively worse for leg pain and EQ-5D.

It is important to note that findings of inferiority are not necessarily important on an individual basis. Indeed, the obese patient seen in clinic only cares about improvement relative to his or her own baseline and nonoperative management. To this point, this study and prior analyses have found both obese and nonobese patients improve significantly with regards to pain, disability, and quality of life from baseline values.[15,16] In fact, obesity has been associated with superior treatment effects (ie, the impact of surgery as compared to nonsurgical management) and worse outcomes with nonoperative management.[15,16] Though obese patients had significantly less improvement compared to nonobese patients with regards to SF-36 physical function scores,[15] Rihn et al[15] did show that obese patients have a greater treatment effect compared to nonoperative management. Other studies have actually demonstrated superiority for select outcomes in obese patients. In McGuire et al,[16] extreme obesity (BMI $\geq$ 35) portended a greater improvement from baseline for the mental component summary of the SF-36 at 12 mo. Taken together, the findings of inferiority in between-group comparisons should not preclude well-selected obese patients from undergoing surgery for degenerative lumbar spondylolisthesis.

In the present study, our multivariate analysis did not find that BMI was associated with satisfaction at 12 mo. This finding is similar to an analysis by McGuire et al[16] who found no difference in postoperative symptomatic satisfaction (as measured by change from baseline measures) at 12 mo between obese and nonobese patients with degenerative lumbar spondylolisthesis. This is in contrast to other large registry study of lumbar stenosis patients in general where obese patients did experience less satisfaction with surgery.[18] Further study is necessary to determine the interaction between obesity and satisfaction following surgery for degenerative lumbar spondylolisthesis.

Likewise, we did not find that BMI was associated with worse ODI or back pain at 12 mo. This is similar to the previous SPORT subgroup analyses, who both found no difference between obese and nonobese surgically treated patients for the primary outcome of ODI and secondary outcome of low back pain bothersomeness.[15,16]

Study Limitations

This study has several limitations including those inherent to a large, multicenter registry. As a nonrandomized evaluation of a breadth of practice patterns, we cannot control for baseline in between-group differences. These baseline differences—including inferior pain, disability, and quality of life in the obese cohort—confound the ability to compare individual outcomes at specific time intervals. Nonetheless, we corrected for these confounders and baseline differences via multivariate analysis and found that obesity remained associated with inferior 12-mo PROs. Additionally, despite its many strengths, the registry is without some important patient characteristics (eg, preoperative and postoperative opioid use) and surgical variables (eg, whether staged surgeries were on same or different days) that may also affect patient outcomes. As a registry, it is not feasible to standardize surgical decision making, surgical technique, or patient characteristics. The characteristics of the obese population studied herein, which includes the "real world" experience of 12 high-volume spine surgery centers, are similar to those reported in prior studies. The obese patients were younger, had increased comorbidities, and socioeconomic disparities.[16] We found that obese patients more often underwent fusion procedures. This is in accordance to the prior SPORT subgroup analyses, where obese patients more often underwent fusion procedures (97.4% vs 91.4%)[16] as well. These similarities in obese patients studied aids in the generalizability of the remainder of the findings from our study.

Of note, the spondylolisthesis study group utilizes a subset of QOD registry sites. It is possible that the spondylolisthesis study group findings may differ from that of the overall registry. However, this practical design—which permits the allocation of dedicated study coordinators and staff—facilitates ongoing auditing of our prospective database and ensures data accuracy.

The present study is limited to 12-mo outcome data—the standard for the QOD registry. Further study is important to confirm the durability of our findings at longer follow-up time points. Still, several studies have suggested that 12-mo outcomes may sufficiently predict longer follow-up time points—specifically 2-yr outcomes following lumbar spine surgery.[35,36]

Though the observational nature of the study prevents identification of causality between obesity and inferior outcomes, the results are suggestive. It may be prudent for patients to consider weight loss or surgeons to consider implementing a weight-loss "surgical package" prior to surgery for degenerative grade 1 spondylolisthesis.

CONCLUSION

In adjusted analyses of 797 patients undergoing surgery for grade 1 degenerative lumbar spondylolisthesis, obesity is independently associated with worse leg pain and quality of life 12 mo following surgery. However, regardless of weight, all patients achieved significant improvements in all domains at 3 and 12-mo time points compared to baseline. Therefore, obesity should not preclude well-selected patients from undergoing surgery for lumbar spondylolisthesis.

Disclosures

Dr Mummaneni is a consultant for DePuy Spine, Globus, and Stryker; has direct stock ownership in Spinicity/ISD; receives clinical/research support for this study from NREF, royalties from DePuy Spine, Thieme Publishers, and Springer Publishers, a grant from AOSpine, and honoraria from Spineart. Dr Bisson is a consultant for nView. Dr Glassman is an employee of Norton Healthcare; is a patent holder with, consultant for, and receives royalties from Medtronic; NuVasive provides funds directly to the database company (no funds are paid directly to individual or institution); and is past president of the Scoliosis Research Society. Dr Foley is a consultant for, has direct stock ownership in, and is a patent holder with Medtronic; has direct stock ownership in NuVasive and Spine Wave. Dr Slotkin is a consultant for Stryker Spine and Medtronic. Dr C. I. Shaffrey has direct stock ownership in, is a consultant for, and patent holder with NuVasive; is a consultant for Zimmer Biomet, a patent holder with Medtronic and Zimmer Biomet. Dr Coric is a consultant for and has direct stock ownership in Spine Wave; is a consultant for Stryker, Medtronic and Premia Spine; and has direct stock ownership in Premia Spine and Spinal Kinetics. Dr Knightly is on the NPA board of directors. Dr Park is a consultant for and receives royalties from Globus; is a consultant for NuVasive, Allosource, and Medtronic. Dr Wang is a patent holder with and receives royalties from DePuy Synthes Spine, Inc; is a consultant for DePuy Synthes Spine, JoiMax USA, K2M, and Aesculap Spine; is on the medical advisory board of Vallum; has direct stock ownership in Spinicity; and receives grants from the Department of Defense. Dr Fu is a consultant for SI-BONE. Dr Haid is a consultant for and receives royalties from Nuvasive; has ownership Interest in Spine Universe; and receives royalties for Medtronic Sofamor Danek. We would also like to thank the Neurosurgery Research and Education Foundation for its financial support of this work. The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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Acknowledgment

We thank all of the site research coordinators for their help with data extraction and validation. We also thank the Neurosurgery Research and Education Foundation (NREF) for its financial support of this work.

COMMENTS

The authors present a relevant study on the relationship between obesity and surgical outcomes for patients with lumbar spondylolisthesis. The obese patients do well; but, they do not do as well as their non-obese counterparts. This was especially true for leg pain and quality of life metrics.

The takeaway message is that weight reduction is probably a worthwhile pre-surgical goal.

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Twelve of the highest-enrolling sites participate in QOD were queried for surgical treatment outcomes after degenerative grade I spondylolisthesis. Study period covered July 2014 through December 2015 with 3 and 12 months of follow-up data. Standard patient demographic information and PRO were studied respective to obesity, defined as BMI ≥ 30. Although the obese group had inferior baseline status, they also achieved significant improvement overall. Two outcome measures were definitely worse for the obese group at 12 months.

As with as multicenter, large database study, the authors addressed the usual shortcoming of such study. It is still valuable information the authors are presenting here. Surgery with or without a fusion provides improvement for both the obese and non-obese cohort of patients in QOD. We can carry on a conversation and discussion about necessity of a spinal fusion in addition to decompression for degenerative grade I spondylolisthesis in the future.

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