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Sexual Dysfunction: Prevalence and Prognosis in Patients Operated for Degenerative Lumbar Spondylolisthesis

BACKGROUND: There is a paucity of investigation on the impact of spondylolisthesis surgery on back pain-related sexual inactivity.

OBJECTIVE: To investigate predictors of improved sex life postoperatively by utilizing the prospective Quality Outcomes Database (QOD) registry.

METHODS: A total of 218 patients who underwent surgery for grade 1 degenerative lumbar spondylolisthesis were included who were sexually active. Sex life was assessed by Oswestry Disability Index item 8 at baseline and 24-mo follow-up.

RESULTS: Mean age was 58.0 ± 11.0 yr, and 108 (49.5%) patients were women. At baseline, 178 patients (81.7%) had sex life impairment. At 24 mo, 130 patients (73.0% of the 178 impaired) had an improved sex life. Those with improved sex lives noted higher satisfaction with surgery (84.5% vs 64.6% would undergo surgery again, $P = .002$). In multivariate analyses, lower body mass index (BMI) was associated with improved sex life (OR = 1.14; 95% CI [1.05-1.20]; $P < .001$). In the younger patients (age < 57 yr), lower BMI remained the sole significant predictor of improvement (OR = 1.12; 95% CI [1.03-1.23]; $P = .01$). In the older patients (age ≥ 57 yr)—in addition to lower BMI (OR = 1.12; 95% CI [1.02-1.27]; $P = .02$)—lower American Society of Anesthesiologists (ASA) grades (1 or 2) (OR = 3.7; 95% CI [1.2-12.0]; $P = .02$) and ≥ 4 yr of college education (OR = 3.9; 95% CI [1.2-15.1]; $P = .03$) were predictive of improvement.

CONCLUSION: Over 80% of patients who present for surgery for degenerative lumbar spondylolisthesis report a negative effect of the disease on sex life. However, most patients (73%) report improvement postoperatively. Sex life improvement was associated with greater satisfaction with surgery. Lower BMI was predictive of improved sex life. In older patients—in addition to lower BMI—lower ASA grade and higher education were predictive of improvement.

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

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Degenerative lumbar spondylolisthesis is a common cause of low back pain in the United States, with an estimated prevalence of 11.5%.¹ For well-selected, symptomatic

patients who fail conservative management, surgical treatment is considered and has been shown to be efficacious.²⁻⁴ Multiple patient-reported outcome (PRO) metrics have been utilized in the assessment of surgical efficacy for degenerative spondylolisthesis.⁵ These have included measures for low back pain-related disability [ie, Oswestry Disability Index (ODI)], health-related quality of life [eg, Short-Form 36 (SF-36) and EuroQol-5D (EQ-5D)], back and leg pain [eg, Numeric Rating Scale (NRS) back pain and leg pain], and patient satisfaction metrics [eg, North American Spine Society (NASS) satisfaction score].^{2-4,6,7} However,

ABBREVIATIONS: ASA, American Society of Anesthesiologists; BMI, body mass index; BSFI, brief sexual function inventory; CSFQ-14, changes in sexual function questionnaire-14; FSFI, female sexual function index; CI, confidence interval; MI, minimally invasive; NASS, North American Spine Society; NRO, Numeric Rating Scale; QOD, Quality Outcomes Database; ODI, Oswestry Disability Index; PRO, patient-reported outcome

sexual function and sex life are notable components of health-related quality of life that have not been well studied despite the prevalence of degenerative lumbar spondylolisthesis.

Though there are studies investigating the impact of surgery on sexual function for urologic,⁸ obstetrical,⁹ and gynecologic procedures,¹⁰ there have been few studies investigating sexual function as it pertains to spinal pathology. In the limited study on the topic, results have been somewhat mixed.¹¹⁻¹⁷ In 2 studies following sexual function after cervical spine surgery, one¹² noted improvement in 91% of patients, whereas another¹³ noted an alarmingly low rate (5%) of patients noting improvement. On the other hand, a study on lumbar disc herniation revealed there were no significant improvements in sex life for males and females at latest follow up¹¹ whereas other studies on the lumbar spine in general demonstrated improved sex life postoperatively.^{14,15,17} Clearly, further investigations are warranted to elucidate the effect of spine surgery on sex life.

To this end, we utilized a prospective registry to analyze the sex life of patients with symptomatic, single-level degenerative lumbar spondylolisthesis pre- and postoperatively. Additionally, we sought to identify factors predictive of improvement in sex life following spondylolisthesis surgery.

METHODS

The Quality Outcomes Database (QOD) is a prospective, multi-center, multidisciplinary registry. Twelve of the highest-enrolling QOD sites participate in the lumbar spondylolisthesis module.^{2,6,18-20} Informed consent and institutional review board approval was obtained (University of California, San Francisco, IRB 16-20085).

We queried this module from July 2014 through June 2016 for patients undergoing single-segment surgery for grade 1 lumbar spondylolisthesis (ie, surgery involving only a single disc space) ($n = 608$). Inclusion and exclusion criteria for the dataset have been published previously.^{2,6,18-20} Briefly, spine surgeons at each site reviewed preoperative plain films (standing or dynamic) to confirm the diagnosis of grade 1 spondylolisthesis as defined by Meyerding.²¹ Patients were included for whom item 8 of the ODI was deemed applicable—via a provided response (eg, younger patients)—at baseline and 24-mo follow-up ($n = 218$). Item 8 of the ODI has been validated as a measure of chronic low back pain-mediated sexual inactivity.²² The item poses the

TABLE 1. Item 8 of the Oswestry Disability Index

This next item will ask whether pain interferes with your sexual activity. With regards to pain, how would you say your sex life is?

Item score	Description
0 (no impairment)	Normal and causes no extra pain
1	Normal, but causes some extra pain
2	Nearly normal, but is very painful
3	Severely restricted by pain
4	Nearly absent because of pain
5 (most impairment)	Not sexually active because of pain

following question: “This next item will ask whether pain interferes with your sexual activity. With regards to pain, how would you say your sex life is?” Responses were graded 0 through 5 in order of increasing severity of disability (Table 1). Respondents were instructed to leave the field blank if the item was not applicable.

We excluded those with grade II or higher spondylolisthesis. All variables were audited for data element accuracy.

Demographic, Clinical, and Surgical Variables

Demographic variables, patient comorbidities, clinical characteristics, and surgical variables were collected. Readmissions and reoperations were recorded if deemed related to surgery.

Primary and Secondary Outcomes

We assessed outcomes at baseline and 24 mo using validated questionnaires. The primary outcome was the score of item 8 of the ODI (range 0-5, with higher scores indicating more back pain-mediated sexual inactivity²²). Patients reporting a score of 0 were defined to have no sexual impairment. Patients reporting a score greater than 0 were defined to have sexual impairment.

Secondary outcomes included ODI,²³ NRS back pain,²⁴ NRS leg pain,²⁴ EQ-5D questionnaire,²⁵ and NASS satisfaction questionnaire.²⁶ The NASS satisfaction questionnaire assesses patient satisfaction postoperatively via a survey with 4 answer choices, 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; and I am the same or worse as compared to before surgery.

Statistical Analysis

Descriptive statistics were reported as means and standard deviations and frequencies and percentages where appropriate. For multivariate analyses, logistic regression models were fit for (1) improvement in sexual impairment (outcome) in the subset of patients with baseline sexual impairment and (2) worsening in sex life (outcome) following surgery. A patient was defined to have improvement when a patient with a score greater than 0 at baseline subsequently went to a lower score at 24-mo follow-up. Alternatively, a patient was defined to have worsening when the 24-mo follow-up score was a higher value than at baseline. For the models, covariates included preoperative factors reaching $P < .20$ on univariate comparisons. These analyses were conducted using R 2.15.2 (R: A Language and Environment for Statistical Computing; R Foundation for Statistical Computing, Vienna, Austria). Missing values

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were imputed using the “missForest” R package. *P* values were 2-tailed, and $\alpha = 0.05$ was considered statistically significant.

RESULTS

Two-hundred and eighteen patients were included who responded to ODI item 8. Baseline characteristics are provided in Table 2. The mean age was 58.0 ± 11.0 yr. A total of 108 (49.5%) were female. Mean BMI was 30.8 ± 6.6 . At baseline, patients were severely disabled (mean ODI 47.0 ± 17.5).

The distribution of low back-pain related sexual inactivity responses over the study period are reported in Figure A. At baseline, 178 (81.7%) reported some sexual impairment. Overall, 91 (41.7%) patients reported a normal sex life with 40 (18.3%) patients reporting that sex life was normal and resulted in no pain, whereas 51 (23.4%) reported that sex life was normal but caused some extra pain. On the other hand, 40 (18.3%) reported that their sex life was absent because of the pain. Compared to baseline, surgery was associated with a significant improvement in sex life at 3 mo ($\chi^2 = 67.4$; *df* = 5; *P* < .001), which was durable through 24 mo ($\chi^2 = 66.0$; *df* = 5; *P* < .001).

Of the 178 (81.7%) who reported some degree of sexual impairment, 130 (73.0%) had improvement in sex life at 24-mo follow-up. Characteristics of those with baseline sexual impairment who noted improvement at 24 mo are presented in Table 3. The distribution of low back-pain related sexual inactivity responses for patients with baseline sexual impairment are reported in Figure B. Of note, 131 (73.6%) patients with baseline impairment were able to resume a normal sex life at 24-mo follow-up. A total of 83 (46.6%) of the patients reported that they were able to resume a normal, pain-free sex life, whereas 48 (27.0%) were able to resume a normal sex life with some residual pain. Of those with baseline impairment, 48 (27.0%) reported that their sex life was the same or worse at 24-mo follow-up. Characteristics of those with baseline sexual impairment who noted no improvement at 24 mo are presented in Table 3.

Figure C shows the distribution of low back-pain related sexual inactivity scores for those without baseline impairment. Of note, 28 (70.0%) remained unimpaired, whereas 7 (17.5%) had a normal sex life with associated pain. Postoperatively, 2 (5.0%) patients reported that sex life was severely restricted by pain, whereas 3 (7.5%) patients reported that sex life was absent because of the pain.

Characteristics of Those With and Without Baseline Impairment

Table 2 compares the clinical characteristics of those with and without baseline impairment. Those impaired at baseline were younger (mean 57.0 ± 11.1 vs 62.3 ± 9.6 yr, *P* = .01) and had a higher proportion with depression (21.9% vs 7.5%, *P* = .04). Those with baseline impairment had worse baseline ODI, NRS back pain, NRS leg pain, and EQ-5D (*P* < .001, *P* = .001, *P* < .001, and *P* = .01, respectively). Those with impairment more often underwent fusion surgeries (94.4% vs

72.5%, *P* < .001). Additionally, those with baseline impairment had longer surgeries (mean 197.4 ± 88.4 vs 156.4 ± 68.0 min, *P* = .01) and hospital stays (mean 3.0 ± 1.6 vs 2.1 ± 1.6 d, *P* = .001) (Table 4).

Table 5 compares the PRO of those with and without baseline impairment. Those with impairment at baseline had a higher mean improvement in ODI (-27.7 ± 19.1 vs -15.8 ± 16.8 , *P* < .001). Otherwise, there were no significant differences for NRS back pain, NRS leg pain, EQ-5D, and NASS satisfaction.

Predictors of Improved Sex Life

Table 3 compares the characteristics of those with baseline impairment who improved postoperatively vs those who were the same or worse postoperatively. Mean BMI was lower in those who improved (29.6 ± 5.5 vs 34.4 ± 6.0 ; *P* < .001), and patients were healthier (ASA grades 1 or 2 61.5% vs 41.7%; *P* = .01). A higher proportion was independently ambulatory in the improved group (94.6% vs 79.2%; *P* = .005). A higher proportion in the improved cohort had ≥ 4 yr of college-level education (41.5% vs 20.8%; *P* = .01) and use of private insurance (70.0% vs 54.2%; *P* = .048). More surgeries in the improved cohort utilized minimally invasive (MI) techniques (43.1% vs 25.0%; *P* = .03). There were no differences in surgical approach (*P* = .86) or whether the procedure involved a fusion (*P* = .88). At baseline, both cohorts had similar disability, back pain, and leg pain. However, the improved cohort had a higher baseline quality of life (EQ-5D 0.52 ± 0.23 vs 0.44 ± 0.24 ; *P* = .04).

Table 6 compares the perioperative outcomes of the cohorts who improved vs those that did not improve. Mean blood loss was lower for those that improved (199.9 ± 174.5 vs 293.5 ± 279.1 mL; *P* = .009). Otherwise, operative time, lengths of hospitalization, discharge disposition, readmission rate, and reoperation rates were similar (*P* = .73, *P* = .52, *P* = .08, *P* = .59, and *P* = .39, respectively).

Table 7 shows the change in PRO scores between 24-mo follow-up and baseline for patients with baseline sexual impairment stratified by 24-mo improvement in sex life. Those with improved sex life demonstrated significantly greater improvements in ODI, NRS back pain, NRS leg pain, and EQ-5D (*P* < .001, *P* < .001, *P* < .001, and *P* = .002, respectively). Those with improved sex life were significantly more satisfied with surgery than those who did not appreciate sex life improvement (84.5% vs 64.6% would undergo surgery again, *P* = .002).

Multivariate Analysis

We sought to define predictors of sex life improvement in the subset of patients with impaired function at baseline. The model was adjusted for factors reaching *P* < .20 on univariate comparisons. Table 8 reveals the covariates and associated odds ratios for the model. Adjusting for potential confounders, the sole predictor of sex life at 24 mo was BMI. Lower BMI exerted a positive effect, predisposing to improvement following surgery (OR = 1.14 per 1 unit lower in BMI; 95% CI [1.05-1.20]; *P* < .001).

TABLE 2. Univariate Analysis of Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	All (n = 218)	Not impaired at baseline (n = 40)	Impaired at baseline (n = 178)	P value
Age (yr), mean ± SD	58.0 ± 11.0	62.3 ± 9.6	57.0 ± 11.1	.01**
Female, n (%)	108 (49.5)	18 (45.0)	90 (50.6)	.52
BMI, mean ± SD	30.8 ± 6.6	30.2 ± 8.7	30.9 ± 6.0	.56
Smoker, n (%)	26 (11.9)	1 (2.5)	25 (14.0)	.08
Comorbidities, n (%)				
Diabetes mellitus	29 (13.3)	5 (12.5)	24 (13.5)	.87
Coronary artery disease	30 (13.8)	4 (10.0)	26 (14.6)	.44
Anxiety	36 (16.5)	4 (10.0)	32 (18.0)	.22
Depression	42 (19.3)	3 (7.5)	39 (21.9)	.04**
Osteoporosis	10 (4.6)	2 (5.0)	8 (4.5)	.78
Dominant presenting symptom, n (%)				.12
Back pain dominant	84 (38.5)	11 (27.5)	73 (41.0)	
Leg pain dominant	30 (13.8)	9 (22.5)	21 (11.8)	
Back pain = leg pain	104 (47.7)	20 (50.0)	84 (47.2)	
Motor deficit present at presentation, n (%)	44 (20.2)	12 (30.0)	32 (18.0)	.09
Independently ambulatory, n (%)	199 (91.3)	38 (95.0)	161 (90.4)	.54
Symptom duration, n (%)				.66
< 3 mo	6 (2.8)	2 (5.0)	4 (2.2)	
> 3 mo	209 (95.9)	37 (92.5)	172 (96.6)	
ASA grade, n (%)				.92
1 or 2	124 (56.9)	24 (60.0)	100 (56.2)	
3 or 4	85 (39.0)	16 (40.0)	69 (38.8)	
Ethnicity, n (%)				.86
Hispanic or Latino	15 (6.9)	2 (5.0)	13 (7.3)	
Education level, n (%)				.68
4 yr of college education or more	77 (35.3)	13 (32.5)	64 (36.0)	
Employment status, n (%)				.89
Employed or employed and on leave	122 (56.0)	22 (55.0)	100 (56.2)	
Private insurance, n (%)	144 (66.1)	27 (67.5)	117 (65.7)	.83
Surgical approach, n (%)				.96 ¹
Posterior	193 (88.5)	36 (90.0)	157 (88.2)	
Anterior only	7 (3.2)	2 (5.0)	5 (2.8)	
Lateral only	2 (0.9)	0 (0.0)	2 (1.1)	
Two-stage	16 (7.3)	2 (5.0)	14 (7.9)	
Minimally invasive techniques utilized, n (%)	86 (39.4)	18 (45.0)	68 (38.2)	.43
Addition of fusion to procedure, n (%)	197 (90.4)	29 (72.5)	168 (94.4)	<.001**
ODI, baseline, mean ± SD	47.0 ± 17.5	30.4 ± 17.9	50.7 ± 15.1	<.001**
NRS back pain, baseline, mean ± SD	6.7 ± 2.6	5.5 ± 3.1	7.0 ± 2.3	.001**
NRS leg pain, baseline, mean ± SD	6.4 ± 3.0	4.9 ± 3.4	6.7 ± 2.8	<.001**
EQ-5D, baseline, mean ± SD	0.52 ± 0.23	0.62 ± 0.23	0.50 ± 0.23	.01**

BMI, body mass index; ASA, American Society of Anesthesiologists; MIS, minimally invasive surgery; ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; EQ-5D, EuroQol-5D; n/a, not applicable. Values do not add up to 100% where there is missing data.

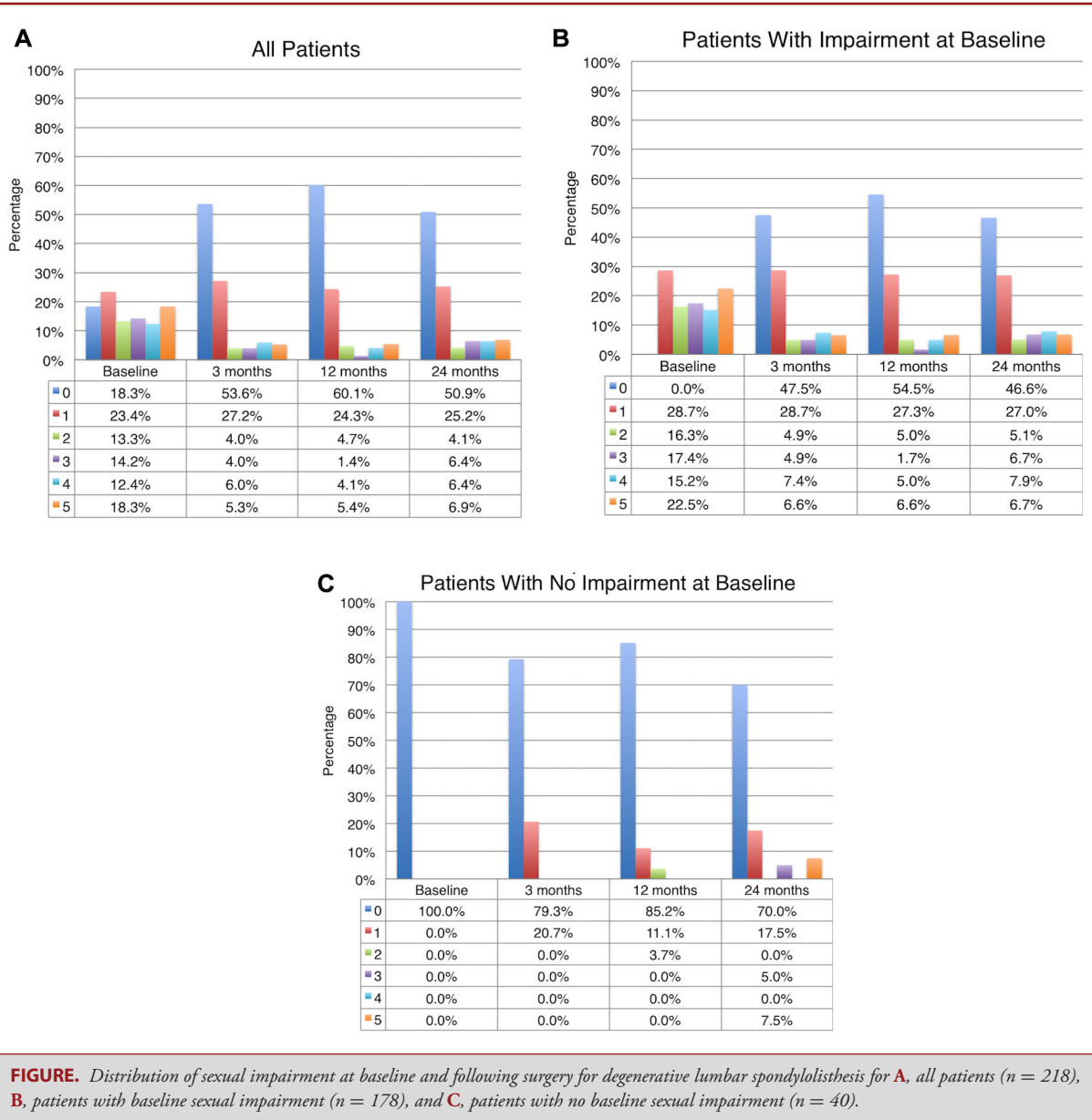
**Denotes a significant difference with *P* value < .05.

Chi-square comparison between posterior vs nonposterior approaches.

The left column represents all eligible patients for the study who were (1) sexually active and (2) had sexual function outcomes recorded at baseline and at 24 mo. The second column represents patients with no sexual impairment at baseline. The third column represents patients with sexual impairment at baseline.

To assess the specificity of predictor identification with regards to age, we repeated the multivariate analyses in the younger portion of the cohort (<57 yr of age) and the older portion of the cohort (≥57 yr) separately (Table 9). The split was chosen given that 57 yr approximated the mean age of the cohort. In

the younger patients, BMI remained the sole predictor of sex life at 24 mo (OR = 1.12 per 1 unit change in BMI; 95% CI [1.03-1.23]; *P* = .01). In the older patients, in addition to BMI (OR = 1.12 per 1 unit change in BMI; 95% CI [1.02-1.27]; *P* = .02), ASA grades 1 or 2 were a significant predictor



of sex life improvement (OR = 3.71; 95% CI [1.21-12.04]; $P = .02$). Additionally, having ≥ 4 yr of college-level education was predictive of improved sex life (OR = 3.94; 95% CI [1.22-15.12]; $P = .03$).

Predictors of Worsened Sex Life

We repeated a similar analysis to identify predictors of worsened sex life postoperatively. Of all 218 patients, 31 (14.2%) reported worsened sex life 24 mo postoperatively, whereas 187 (85.8%) reported the same or improved sex life. Univariate comparisons revealed that those with worsened sex life had a

higher mean BMI (33.1 ± 8.4 vs 30.4 ± 6.2 , $P = .03$) and ASA grade (64.5% vs 36.6% ASA grades 3 or 4, $P = .003$). Furthermore, those with worsened sex life had a lower proportion of patients with ≥ 4 yr of college-level education (19.4% vs 38.0%, $P = .04$). The remaining baseline demographic and clinical variables were similar ($P > .05$). Of note, there were no surgical factors associated with worsened sex life, including surgical approach ($P = .97$), whether a fusion was performed ($P = .74$) or whether MI techniques were utilized ($P = .20$). A multivariate model adjusting for factors reaching $P < .20$ on univariate comparisons did not identify a significant individual predictor of worsened sex life postoperatively.

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TABLE 3. Univariate Analysis of Patients with Baseline Impairment of Sex Life Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	Baseline impaired, improved function (n = 130)	Baseline impaired, same or worse function (n = 48)	P value
Age (yr), mean ± SD	57.1 ± 11.8	56.7 ± 9.2	.81
Female, n (%)	67 (51.5)	23 (47.9)	.67
BMI, mean ± SD	29.6 ± 5.5	34.4 ± 6.0	<.001**
Smoker, n (%)	20 (15.4)	5 (10.4)	.40
Comorbidities, n (%)			
Diabetes mellitus	17 (13.1)	7 (14.6)	.79
Coronary artery disease	18 (13.8)	8 (16.7)	.64
Anxiety	24 (18.5)	8 (16.7)	.78
Depression	29 (22.3)	10 (20.8)	.83
Osteoporosis	7 (5.4)	1 (2.1)	.59
Dominant presenting symptom, n (%)			.68
Back pain dominant	53 (40.8)	20 (41.7)	
Leg pain dominant	17 (13.1)	4 (8.3)	
Back pain = leg pain	60 (46.2)	24 (50.0)	
Motor deficit present at presentation, n (%)	25 (19.2)	7 (14.6)	.47
Independently ambulatory, n (%)	123 (94.6)	38 (79.2)	.005**
Symptom duration, n (%)			n/a
<3 mo	4 (3.1)	0 (0)	
>3 mo	124 (95.4)	48 (100)	
ASA grade, n (%)			.01**
1 or 2	80 (61.5)	20 (41.7)	
3 or 4	43 (33.1)	26 (54.2)	
Ethnicity, n (%)			.99
Hispanic or Latino	10 (7.7)	3 (6.3)	
Education level, n (%)			.01**
4 yr of college education or more	54 (41.5)	10 (20.8)	
Employment status, n (%)			.18
Employed or employed and on leave	77 (59.2)	23 (47.9)	
Private insurance, n (%)	91 (70.0)	26 (54.2)	.048**
Surgical approach, n (%)			.86 ¹
Posterior	115 (88.5)	42 (87.5)	
Anterior only	4 (3.1)	1 (2.1)	
Lateral only	2 (1.5)	0 (0)	
Two-stage	9 (6.9)	5 (10.4)	
Minimally invasive techniques utilized, n (%)	56 (43.1)	12 (25.0)	.03**
Addition of fusion to procedure, n (%)	123 (94.6)	45 (93.8)	.88
ODI, baseline, mean ± SD	50.5 ± 14.7	51.1 ± 16.4	.82
NRS back pain, baseline, mean ± SD	7.0 ± 2.4	7.1 ± 2.0	.75
NRS leg pain, baseline, mean ± SD	6.8 ± 2.8	6.6 ± 2.8	.70
EQ-5D, baseline, mean ± SD	0.52 ± 0.23	0.44 ± 0.24	.04**

BMI, body mass index; ASA, American Society of Anesthesiologists; MIS, minimally invasive surgery; ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; EQ-5D, EuroQol-5D; n/a, not applicable. Values do not add up to 100% where there is missing data.

**Denotes a significant difference with *P* value < .05.

Chi-square comparison between posterior vs nonposterior approaches.

The left column represents patients with improved sexual function at 24 mo with sexual impairment at baseline. The middle column represents patients with same or worse sexual function at 24 mo with sexual impairment at baseline.

DISCUSSION

To the best of our knowledge, this is the first study to report the effect of degenerative lumbar spondylolisthesis on sexual activity and the outcomes following surgical intervention. At baseline,

only 18.3% of patients with symptomatic, single-level disease reported having a normal sex life without pain. Surgery was associated with significant improvements in sex life, with 73% of patients with baseline impairment noting an improvement 2 yr following surgery. Compared to patients who noted no

TABLE 4. Univariate Analysis of Hospital Data for Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	All (n = 218)	Not impaired at baseline (n = 40)	Impaired at baseline (n = 178)	P value
Estimated blood loss (mL), mean ± SD	218.8 ± 212.9	188.7 ± 217.9	225.6 ± 211.8	.33
Operative time (min), mean ± SD	190.3 ± 6.5	156.4 ± 68.0	197.4 ± 88.4	.01**
Length of hospitalization (d), mean ± SD	2.8 ± 1.6	2.1 ± 1.6	3.0 ± 1.6	.001**
Discharge disposition				.59
Home or home health care, n (%)	206 (94.5)	39 (97.5)	167 (93.8)	
Other than home or home health care, n (%)	12 (5.5)	1 (2.5)	11 (6.2)	
Readmissions, 3 mo, n (%)	8 (3.7)	1 (2.5)	7 (3.9)	.97
Reoperations, 24 to 36 mo follow up, n (%)	25 (11.5)	5 (12.5)	20 (11.2)	.96
Deaths, n (%)	0 (0)	0 (0)	0 (0)	n/a

mL, milliliters; n/a, not applicable.

**Denotes a significant difference with P-value < .05.

The left column represents all eligible patients for the study who were (1) sexually active and (2) had sexual function outcomes recorded at baseline and at 24 mo. The second column represents patients with no sexual impairment at baseline. The third column represents patients with sexual impairment at baseline.

TABLE 5. Univariate Analysis of 24-mo Patient Reported Outcomes for Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	All (n = 218)	Not impaired at baseline (n = 40)	Impaired at baseline (n = 130)	P value
ODI, change, mean ± SD	-25.5 ± 19.2	-15.8 ± 16.8	-27.7 ± 19.1	<.001**
NRS back pain, change, mean ± SD	-3.8 ± 3.2	-3.2 ± 3.5	-3.9 ± 3.1	.23
NRS leg pain, change, mean ± SD	-3.7 ± 3.9	-3.0 ± 3.8	-3.8 ± 3.9	.25
EQ-5D, change, mean ± SD	+0.24 ± 0.25	0.20 ± 0.23	+0.25 ± 0.25	.27
NASS satisfaction, n (%)				.60
1	131 (60.1)	22 (55.0)	109 (61.2)	
2	42 (19.3)	9 (22.5)	33 (18.5)	
3	13 (6.0)	4 (10.0)	9 (5.1)	
4	18 (8.3)	4 (10.0)	14 (7.9)	

ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; EQ-5D, EuroQol-5D; NASS, North American Spine Society.

**Denotes a significant difference with P value < .05.

The left column represents all eligible patients for the study who were (1) sexually active and (2) had sexual function outcomes recorded at baseline and at 24 mo. The second column represents patients with no sexual impairment at baseline. The third column represents patients with sexual impairment at baseline.

improvement in sex life following surgery, those who improved noted significantly higher satisfaction postoperatively. In multivariate analysis, when adjusting for confounding variables, lower BMI was the only significant predictor of improved sex life postoperatively. In the subgroup analysis of the older patients—in addition to lower BMI—lower ASA grade and having ≥4 yr of college education were also significant predictors of improved sex life.

In our study, among those sexually active, it appears a majority (~82%) of patients with degenerative lumbar spondylolisthesis have an impaired sex life because of back pain. Despite the prevalence of impairment among patients, low back pain-related sexual inactivity has not been well-studied following spondylolisthesis surgery. Given that sex life is an important component of patient-

centered outcomes and health-related quality of life, further study should be conducted on the topic. Specifically, other validated questionnaires for sex life and sexual function may be administered pre- and postoperatively, such as the Changes in Sexual Function Questionnaire-14 (CSFQ-14),²⁷ Brief Sexual Function Inventory (BSFI),²⁸ and Female Sexual Function Index (FSFI).²⁹

Though a high proportion of patients have an impaired sex life because of degenerative lumbar spondylolisthesis at baseline, our results demonstrate that a similarly high proportion (~73%) improve following surgery. Furthermore, as a cohort, significant improvement was observed as early as 3 mo postoperatively, a result that was durable through 24 mo for low back pain-related sexual inactivity. Additionally, improvement in sex life postoperatively was associated with greater satisfaction with

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TABLE 6. Univariate Analysis of Hospital Data for Patients with Baseline Impairment of Sex Life Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	Baseline impaired, improved function (n = 130)	Baseline impaired, same or worse function (n = 48)	P value
Estimated blood loss (mL), mean ± SD	199.9 ± 174.5	293.5 ± 279.1	.009**
Operative time (min), mean ± SD	198.8 ± 93.1	193.8 ± 75.1	.73
Length of hospitalization (d), mean ± SD	3.0 ± 1.7	3.1 ± 1.2	.52
Discharge disposition			.08
Home or home health care, n (%)	125 (96.2)	42 (87.5)	
Other than home or home health care, n (%)	5 (3.8)	6 (12.5)	
Readmissions, 3 mo, n (%)	4 (3.1)	3 (6.3)	.59
Reoperations, 24 to 36 mo follow up, n (%)	13 (10.0)	7 (14.6)	.39
Deaths, n (%)	0 (0)	0 (0)	n/a

mL, milliliters; n/a, not applicable.

**Denotes a significant difference with *P* value < .05.

The left column represents patients with improved sexual function at 24 mo with sexual impairment at baseline. The middle column represents patients with same or worse sexual function at 24 mo with sexual impairment at baseline.

surgery. These observations reveal that sexual impairment for lumbar spondylolisthesis may be more surgically treatment responsive than for lumbar disc herniation¹¹ or cervical pathologies.¹³ For the former, no significant improvement in sex life was realized in a study of 98 patients following lumbar disc herniation surgery using item 8 of the ODI.¹¹ For the latter cervical pathologies, results have been mixed. One study with 59 patients following cervical spine surgery showed that only 5% noted improvement in sexual function following surgery.¹³ The other study, which included 22 male patients with cervical spondylotic myelopathy, showed that 91% noted an improvement in sexual function postoperatively.¹² Our findings are encouraging and suggest that spondylolisthesis surgery is associated with improved sex life for patients with low back pain-related sexual inactivity. This extends the findings of prior studies noting sex life improvement following lumbar spine surgery in general^{14,15} and in a heterogeneous cohort of patients with spinal stenosis and degenerative spondylolisthesis.¹⁷

Our study also addresses the concern as to whether surgery may be associated with a worsening of sex life, especially in those with no baseline impairment. Indeed, a recent publication on sexual function following cervical spine surgery revealed that 39% of patients reported worsened sexual function.¹³ In contrast, here, we report that 14.2% of patients noted worsened sex life 24-mo

TABLE 7. Univariate Analysis of 24-mo Patient Reported Outcomes for Patients With Baseline Impairment in Sex Life Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

	Baseline impaired, improved function (n = 130)	Baseline impaired, same or worse function (n = 48)	P value
ODI, change, mean ± SD	-33.7 ± 16.5	-10.9 ± 15.6	<.001**
NRS back pain, change, mean ± SD	-4.6 ± 2.9	-1.8 ± 2.8	<.001**
NRS leg pain, change, mean ± SD	-4.8 ± 3.5	-1.4 ± 3.9	<.001**
EQ-5D, change, mean ± SD	+0.36 ± 0.28	+0.14 ± 0.24	.002**
NASS satisfaction, n (%)			.002**
1	89 (68.5)	20 (41.7)	
2	22 (16.9)	11 (22.9)	
3	4 (3.1)	5 (10.4)	
4	6 (4.6)	8 (16.7)	

ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; EQ-5D, EuroQol-5D; NASS, North American Spine Society.

**Denotes a significant difference with *P* value < .05.

The left column represents patients with improved sexual function at 24 mo with sexual impairment at baseline. The middle column represents patients with same or worse sexual function at 24 mo with sexual impairment at baseline.

TABLE 8. Multivariate Model of Improved Sexual Function Following Surgery for Those With Impaired Sexual Function at Baseline

	Adjusted ¹ odds ratio (95% CI)	P value
Private insurance	1.34 (0.53-3.33)	.53
Independent ambulation at baseline	2.94 (0.88-10.12)	.08
BMI (per unit lower BMI)	1.14 (1.05-1.20)	<.001**
4 or more years of college level education	2.27 (0.98-5.65)	.06
Employed or employed and on leave	1.20 (0.49-2.90)	.69
ASA grade 1 or 2	1.28 (0.58-2.81)	.53
EQ-5D, baseline	1.00 (0.998-1.005)	.40
Use of minimally invasive techniques	2.07 (0.91-4.93)	.09

BMI, body mass index; EQ-5D, EuroQol-5D.

Odds ratios (OR) are reported such that an OR > 1.0 represents an increased odds of improved sexual function at 24 mo.

¹Multivariate models adjusted for factors with *P* < .20 on univariate comparisons: use of private insurance, whether a patient was independently ambulatory at baseline, BMI, education, employment status, ASA grade (grade 1 or 2 vs grade 3 or 4), baseline EQ-5D, and whether minimally invasive techniques were utilized for surgery.

TABLE 9. Multivariate Model of Improved Sexual Function Following Surgery for Those With Impaired Sexual Function at Baseline Stratified by Age

	Adjusted ¹ odds ratio (95% CI)	P value
Age < 57 yr		
Private insurance	1.46 (0.28-7.28)	.64
Independent ambulation at baseline	3.11 (0.67-15.14)	.15
BMI (per 1 unit lower BMI)	1.12 (1.03-1.23)	.01**
Employed or employed and on leave	0.62 (0.11-2.98)	.56
EQ-5D, baseline	18.23 (0.72-751.40)	.09
Use of minimally invasive techniques	2.81 (0.78-11.94)	.13
Age ≥ 57 yr		
Age (per 1 yr older)	1.04 (0.95-1.15)	.45
Independent ambulation at baseline	2.22 (0.30-20.96)	.45
BMI (per 1 unit lower BMI)	1.12 (1.02-1.27)	.02**
4 or more years of college level education	3.94 (1.22-15.12)	.03**
ASA grade 1 or 2	3.71 (1.21-12.04)	.02**

BMI, body mass index; EQ-5D, EuroQol-5D; ASA, American Society of Anesthesiologists. Odds ratios (OR) are reported such that an OR > 1.0 represents an increased odds of improved sexual function at 24 mo.

¹Multivariate models adjusted for factors with *P* < .20 on univariate comparisons.

postoperatively. Furthermore, in those with no sexual impairment at baseline, 87.5% retained a normal sex life (70% of whom reported sex life that was absolutely pain free) 24 mo postoperatively. In patients with no impairment preoperatively, only 5 patients (12.5%) noted less than normal sexual activity postoperatively. Our results may prove helpful in counseling patients of the high probability of retaining a normal sex life following spondylolisthesis surgery.

Here, we found that increasing obesity was associated with worse sex life following surgery. There is somewhat mixed evidence regarding the effect of obesity on other PROs following lumbar spondylolisthesis surgery. A recent prospective registry study of 797 patients by our group demonstrated that obesity was associated with inferior leg pain and quality of life, through similar back pain, disability, and satisfaction, following surgery for degenerative lumbar spondylolisthesis.¹⁹ Similarly, subgroup analyses of the Spine Patient Outcomes Research Trial for obese patients³⁰ and morbidly obese patients³¹ demonstrated worse outcomes for SF-36 Physical Function, but not ODI and SF-36 Bodily Pain measures. Of note, though obese patients fared significantly worse than nonobese patients for select PRO measures, obese patients still achieved significant benefit from surgery with regards to pain, disability, and quality of life^{19,30,31} and, at times, a greater treatment effect (ie, follow-up value minus baseline value).^{30,31} Though these results should be shared with patients and surgeons considering surgery for degenerative lumbar spondylolisthesis, it is important that they be interpreted cautiously. Namely, they should not be utilized as evidence

for exclusionary criterion for surgery. Though the nature of the present study prohibits establishing a causal link between increasing BMI and less improvement in sex life following surgery, the results may be suggestive and weight loss may be considered preoperatively.

Interestingly, the predictors of improved sex life varied with age. In the subset of older patients (age ≥ 57 yr), in addition to BMI, lower ASA grade and ≥4 yr of college education were also significant predictors of improved sex life. In the subset of younger patients (age < 57 yr), BMI remained the sole significant predictor. The elderly, who have altered cardiovascular and renal physiology, may be less tolerant of comorbidity with surgery and postoperative recovery.³² There was an over 2-fold higher proportion of patients with ≥4 yr of college education in the elderly cohort reporting improvement in sex life, compared to the elderly cohort noting no improvement and the younger cohort, respectively. A higher education may reflect a higher medical literacy, permitting more accurate preoperative expectations and an improved adherence with postoperative therapy regimens, leading to improved surgical outcomes.³³⁻³⁵

We did not find a difference in improvement for males and females, similar to prior investigations on sex life following total disc replacement and fusion surgery for low back pain.¹⁴ On the other hand, Hagg et al¹⁵ demonstrate somewhat mixed results with females noting more frequent improvement in sex life as assessed by ODI item 8 but similar levels of sexual enjoyment assessed by item 6 of the Zung Depression Scale. Interestingly, in an analysis of 98 patients with lumbar disc herniation,¹¹ females noted a significantly higher level of preoperative sexual inactivity than males. However, no significant changes were observed postoperatively for both males and females. The inconsistencies among the aforementioned investigations are likely due to the distinct disease pathologies studied, differing lengths of follow up, and utilization of different statistical methods to compare item 8 of the ODI.

Limitations

This represents a retrospective analysis of prospectively collected data and holds the associated biases. Not all patients may have been forthcoming about a topic such as sex life. Given that a response choice, “not applicable,” was available, some patients that may have been sexually active, but not forthcoming, may have answered “not applicable” to item 8 of the ODI (in addition to patients who were not sexually active in general in whom the question would not apply, eg, the elderly). If the impact of degenerative lumbar spondylolisthesis on sex life varies with patients’ propensity to be forthcoming, then the results may be accordingly affected. Similarly, the ordinal 6-response levels for item 8 may be somewhat susceptible to floor and ceiling effects with regards to the impact of surgery on sex life. Future study should validate our findings with additional batteries of sex life and sexual function. The registry does not include data about the specific level of surgery, which may also affect outcomes related to low back

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pain-related sexual inactivity. Additionally, though surgeons evaluated radiographs for inclusion in the study, radiographs themselves were unavailable for analysis in this study. Future study may conduct a radiographic analysis to assess if there are radiographic determinants of low back pain-related sexual inactivity (eg, extent of decompression achieved, etc).

Lastly, the current dataset reflects the “real-world” outcomes of patients seeking surgery at high-volume spine centers in the United States. The cross-cultural validities of findings reported herein are uncertain and results should be interpreted accordingly.

CONCLUSION

Over 80% of patients who present for surgery for grade I degenerative lumbar spondylolisthesis report a negative effect of the disease on sex life. However, surgery is associated with a significant improvement in sex life, with 73% of patients reporting an improvement in sexual activity at 24 mo following surgery. Patients who noted improvement in sex life were significantly more satisfied with surgery. When adjusting for potential covariates, only lower BMI was significantly predictive of improved sex life following lumbar spondylolisthesis surgery. In older patients, in addition to lower BMI, lower ASA grade, and 4 or more years of college-level education were also predictive of improved sex life. Sex life is an important component of health-related quality of life, and the present results should be shared with patients considering surgery for degenerative lumbar spondylolisthesis.

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COMMENT

The authors utilized a prospective, multicenter registry to evaluate sexual dysfunction following operative intervention for degenerative lumbar spondylolisthesis. Their analysis revealed higher satisfaction after surgery was seen in patients that showed improvements in sexual function postoperatively. They also showed a lower body mass index (BMI) was associated with improvements in sexual life at follow-up. Taken together these findings underscore the significant contribution of sexual function towards the overall well-being of a patient. By focusing on this important topic, which can often be uncomfortable for the patient to acknowledge and discuss, the present analysis serves to increase awareness among members of the surgical team on the impact of surgery on sexual health. Further, the results presented here have the potential to aid future endeavors that look at sexual function in different age groups and clinical conditions related to the spine.

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