



Patients with a depressive and/or anxiety disorder can achieve optimum Long term outcomes after surgery for grade 1 spondylolisthesis: Analysis from the quality outcomes database (QOD)



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ABSTRACT

Introduction: In the current study, we sought to compare baseline demographic, clinical, and operative characteristics, as well as baseline and follow-up patient reported outcomes (PROs) of patients with any depressive and/or anxiety disorder undergoing surgery for low-grade spondylolisthesis using a national spine registry.

Patients and Methods: The Quality Outcomes Database (QOD) was queried for patients undergoing surgery for Meyerding grade 1 lumbar spondylolisthesis undergoing 1–2 level decompression or 1 level fusion at 12 sites with the highest number of patients enrolled in QOD with 2-year follow-up data.

Results: Of the 608 patients identified, 25.6 % (n = 156) had any depressive and/or anxiety disorder. Patients with a depressive/anxiety disorder were less likely to be discharged home (p < 0.001). At 3 = months, patients with a depressive/anxiety disorder had higher back pain (p < 0.001), lower quality of life (p < 0.001) and higher disability (p = 0.013); at 2 year patients with depression and/or anxiety had lower quality of life compared to those without (p < 0.001). On multivariable regression, depression was associated with significantly lower odds of achieving 20 % or less ODI (OR 0.44, 95 % CI 0.21 – 0.94, p = 0.03). Presence of an anxiety disorder was not associated with decreased odds of achieving that milestone at 3 months. The presence of depressive-disorder, anxiety-disorder or both did not have an impact on ODI at 2 years. Finally, patient satisfaction at 2-years did not differ between the two groups (79.8 % vs 82.7 %, p = 0.503).

Conclusion: We found that presence of a depressive-disorder may impact short-term outcomes among patients undergoing surgery for low grade spondylolisthesis but longer term outcomes are not affected by either a depressive or anxiety disorder.

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1. Introduction

According to a recent study, up to 8% of all patients undergoing a major spinal procedure may have a psychiatric disorder, most common among these being depression and anxiety. [1] The same study also found that the incidence of such disorders among patients undergoing spinal surgery has increased significantly in the past 2 decades [1].

Presence of psychiatric disorders has been shown to be associated with poor surgical outcomes among patients undergoing common major surgical procedures including, but not limited to general surgery procedures like cholecystectomy, appendectomy; [2] surgery for cancer of the gastrointestinal tract [2,3]; non-cardiac thoracic surgery [4]; and cardio-thoracic surgery [5]. For spine surgery, studies have analyzed the impact of mental illness on patients undergoing surgery for lumbar spinal stenosis and degenerative spondylolisthesis, cervical spine surgery and deformity surgery [1,6–8]. Such studies often query ICD or CPT-based administrative and insurance databases, and thus focus predominantly on outcomes such as length of stay, non-routine discharge, complications, readmissions and reoperations. Studies assessing the impact of mental illness on patient reported outcomes (PROs) and functional outcomes are scarce. Moreover, it is unclear whether such illnesses impact such outcomes in the short (3 months) or longer term (1 year or more).

In the current study, we analyzed data from a national spine registry to (i) characterize the differences in clinical factors between patients with a diagnosis of any depressive and/or anxiety disorder and (ii) to assess the impact of a diagnosis of an anxiety and/or depressive disorder, on short and longer term clinical as well as patient reported outcomes, among patients undergoing surgery for low-grade degenerative spondylolisthesis.

2. Methods

2.1. Cohort

For the current study, the Quality Outcomes Database (QOD) was queried for patients undergoing surgery for Meyerding grade 1 degenerative lumbar spondylolisthesis between July 1st, 2014 and June 30th, 2016. The QOD is a prospective multi-institutional registry, which was established in 2012 with the goal to evaluate risk-adjusted expected morbidity, 30-day clinical outcomes of interest, 12-month and 24-month patient reported outcomes (PROs) and to establish a data-driven mechanism of providing insights into improving quality of care for routinely performed spine surgeries in the United States. [9–11] As of February 2019, over 78,879 patients undergoing a lumbar surgery for degenerative disease, across 105 participating sites in the nation have been enrolled in the Lumbar spine surgery QOD module [12]. Among the several sites, the 12 highest-enrolling sites came together to initiate a focused project to assess the impact of fusion on PROs in patients undergoing surgery for grade 1 lumbar spondylolisthesis. [13–17] In order to determine the diagnosis of grade 1 spondylolisthesis [18], surgeons at each of the participating sites evaluated pre-operative standing or dynamic x-rays [13–17]. The primary outcome of interest for this study was reaching a Oswestry Disability Index (ODI) of 20 % or below. Informed consent and institutional review board approval were obtained.

2.2. Predictor of interest

For the current study, the cohort was divided into those who had any comorbid depressive or anxiety disorder and those who did not have either. Patients were reported to have a depressive disorder or anxiety disorder if they were listed in the problems list at the time of enrollment in the registry.

2.3. Outcomes of interest

The primary outcome of interest was the Oswestry Disability Index (ODI) score [19] at the 3 month and 2 year follow up. Secondary outcomes of interest included other PROs including the Numeric Rating Score (NRS) back pain, NRS leg pain [20], EQ-5D questionnaire [19], and NASS satisfaction questionnaire [21]. The NASS satisfaction questionnaire assesses satisfaction using a 4 point survey with scores 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,” and “I am the same or worse as compared to before surgery.” We also analyzed perioperative and post-operative clinical outcomes including 30-day readmissions, post-operative length of stay, discharge disposition and reoperations.

2.4. Covariates

The following variables were included in the analyses for the current study(3,671,926) : a) demographics characteristics including age, sex, body mass index (BMI), ethnicity, insurance, education level, employment, worker’s compensation, b) comorbidities including smoking, diabetes, American Society of Anesthesiologists (ASA) classification c) clinical characteristics like symptom duration, dominant symptom, ambulation, presence of motor deficit and d) baseline patient reported outcomes (PROs).

2.5. Statistical analysis

Continuous variables were summarized using medians with interquartile ranges (IQR) or means with standard deviation, and compared using *t*-test. Categorical variables were summarized using frequencies with proportions and compared using chi-square or Fischer’s exact test. We also performed a multivariable linear regression analysis to analyze the outcome of interest, i.e. ODI goal of 20 % or less, at 3 months and 2 years. For the multivariable model, depression and anxiety were assessed separately. Finally, we also added an interaction term for depression and anxiety to see the impact of presence of both anxiety and depression on the outcome. All analyses were performed using 3.3.1 (R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org>), using the “rms” and “Arsenal” package. [22] P values were two-tailed and were considered significant if were less than 0.05.

3. Results

Of the 608 patients, 156 patients (25.6 %) had any depressive and/or anxiety disorder at the time of enrollment into registry. Of these, 48 (13.15 %) had a depressive disorder alone, 33 (5.43 %) had an anxiety disorder alone, while 75 (12.3 %) had both a depressive and an anxiety disorder.

3.1. Demographics, clinical characteristics and operative characteristics

Patients with any depressive/anxiety disorder were more likely to be younger (58.9 ± 11.9 vs 63.31 ± 11.8 , $p < 0.001$), more likely to be females (71.2 %, $n = 111$ vs 52.9 %, $n = 239$, $p < 0.001$), more likely to be current smokers (18.6 %, $n = 29$ vs 9.3 %, $n = 42$, $p = 0.007$), and more likely to be unemployed (62.8 %, $n = 98$ vs 49.8 %, $n = 215$, $p = 0.003$). We did not observe any difference between the two groups in terms of other demographic characteristics including BMI, insurance status, education, or worker’s compensation. We didn’t observe any difference between the two groups in terms of clinical characteristics including the dominant presenting symptom, presence of motor deficit, ambulation status and symptom duration. Patients with depression/anxiety were more likely to undergo fusion (84 %, $n = 131$

Table 1
Demographic and Clinical Characteristics of the Cohort.

| | Total (N = 608) | No Depression or Anxiety (N = 452) | Depression or Anxiety Group (N = 156) | p value |
|---|-----------------|------------------------------------|---------------------------------------|----------------|
| Age | 62.175 (12.035) | 63.314 (11.870) | 58.875 (11.936) | < 0.001 |
| Females | 350 (57.6 %) | 239 (52.9 %) | 111 (71.2 %) | < 0.001 |
| BMI | 30.411 (6.363) | 30.194 (6.435) | 31.039 (6.125) | 0.153 |
| Ethnicity | | | | 0.185 |
| Hispanic | 29 (4.8 %) | 25 (5.5 %) | 4 (2.6 %) | |
| Non-Hispanic | 560 (92.1 %) | 411 (90.9 %) | 149 (95.5 %) | |
| Prefer not to answer | 19 (3.1 %) | 16 (3.5 %) | 3 (1.9 %) | |
| Insurance Status | | | | 0.002 |
| Uninsured | 1 (0.2 %) | 1 (0.2 %) | 0 (0.0 %) | |
| Medicare | 235 (38.7 %) | 179 (39.6 %) | 56 (35.9 %) | |
| Medicaid | 36 (5.9 %) | 19 (4.2 %) | 17 (10.9 %) | |
| VA/Government | 17 (2.8 %) | 8 (1.8 %) | 9 (5.8 %) | |
| Private | 319 (52.5 %) | 245 (54.2 %) | 74 (47.4 %) | |
| Education | | | | 0.167 |
| Less than high school | 17 (2.8 %) | 11 (2.5 %) | 6 (3.8 %) | |
| High school diploma or GED | 238 (39.5 %) | 169 (37.8 %) | 69 (44.2 %) | |
| Two year college | 109 (18.1 %) | 76 (17.0 %) | 33 (21.2 %) | |
| Four year college | 121 (20.1 %) | 97 (21.7 %) | 24 (15.4 %) | |
| Post college | 108 (17.9 %) | 87 (19.5 %) | 21 (13.5 %) | |
| Prefer not to answer | 10 (1.7 %) | 7 (1.6 %) | 3 (1.9 %) | |
| Worker's Compensation | 27 (4.4 %) | 22 (4.9 %) | 5 (3.2 %) | 0.185 |
| Employment | | | | 0.003 |
| Employed and currently working | 244 (41.5 %) | 197 (45.6 %) | 47 (30.1 %) | |
| Employed, but not working | 31 (5.3 %) | 20 (4.6 %) | 11 (7.1 %) | |
| Unemployed | 313 (53.2 %) | 215 (49.8 %) | 98 (62.8 %) | |
| Smoking | 71 (11.7 %) | 42 (9.3 %) | 29 (18.6 %) | 0.007 |
| History of Major Surgery | 70 (11.5 %) | 52 (11.5 %) | 18 (11.5 %) | 0.991 |
| CAD | 68 (11.2 %) | 44 (9.7 %) | 24 (15.4 %) | 0.054 |
| Osteoporosis | 38 (6.2 %) | 26 (5.8 %) | 12 (7.7 %) | 0.388 |
| Dominant Symptom | | | | 0.491 |
| Back dominant | 230 (37.8 %) | 166 (36.7 %) | 64 (41.0 %) | |
| Leg dominant | 131 (21.5 %) | 102 (22.6 %) | 29 (18.6 %) | |
| Back = leg | 247 (40.6 %) | 184 (40.7 %) | 63 (40.4 %) | |
| Motor Deficit | 139 (22.9 %) | 99 (22.0 %) | 40 (25.6 %) | 0.344 |
| Ambulation | | | | 0.818 |
| Independent | 537 (88.3 %) | 400 (88.5 %) | 137 (87.8 %) | |
| With an assist device | 65 (10.7 %) | 47 (10.4 %) | 18 (11.5 %) | |
| Wheelchair bound | 6 (1.0 %) | 5 (1.1 %) | 1 (0.6 %) | |
| Symptom Duration | | | | 0.063 |
| Less than 3 months | 15 (2.5 %) | 14 (3.1 %) | 1 (0.6 %) | |
| Greater than 3 months | 571 (93.9 %) | 425 (94.0 %) | 146 (93.6 %) | |
| Unknown | 22 (3.6 %) | 13 (2.9 %) | 9 (5.8 %) | |
| ASA Grade | | | | 0.425 |
| Normal healthy patient | 23 (3.9 %) | 16 (3.7 %) | 7 (4.6 %) | |
| Mild systemic disease | 323 (55.4 %) | 248 (57.4 %) | 75 (49.7 %) | |
| Severe systemic disease | 231 (39.6 %) | 164 (38.0 %) | 67 (44.4 %) | |
| Severe systemic disease that is constant threat to life | 6 (1.0 %) | 4 (0.9 %) | 2 (1.3 %) | |
| Surgical Group | | | | 0.016 |
| Decompression Alone | 140 (23.0 %) | 115 (25.4 %) | 25 (16.0 %) | |
| Decompression and Fusion | 468 (77.0 %) | 337 (74.6 %) | 131 (84.0 %) | |
| MIS Decompression | 226 (37.2 %) | 177 (39.2 %) | 49 (31.4 %) | 0.084 |
| MIS Interbody | 157 (25.8 %) | 124 (27.4 %) | 33 (21.2 %) | 0.122 |

BMI: Body Mass Index; VA: Veterans Affairs; GED: General Educational Development; CAD: Coronary Artery Disease; ASA: American Society of Anesthesiologists; MIS: Minimally Invasive Surgery.

vs 74.6 %, n = 337, p = 0.016). We did not observe any differences between the two groups in terms of ASA grade and use of minimally invasive surgery. These results have been summarized in [Table 1](#).

3.2. Clinical outcomes

Patients with a depressive/anxiety disorder had a longer length of stay (2.97 days \pm 1.78 vs 2.64 days \pm 2.64, p = 0.048), less likely to be discharged home (84.7 %, n = 132 vs 92.7 %, n = 416, p = 0.01), and more likely to undergo a reoperation within 3 years (15.4 %, n = 24 vs 8.8 %, n = 40, p = 0.02). These results have been summarized in [Table 2](#).

3.3. Patient reported outcomes

At baseline, patients with a depressive/anxiety disorder had significantly higher back pain (NRS 7.2 \pm 2.6 vs 6.5 \pm 2.8, p = 0.016) and leg pain (NRS 7.07 \pm 2.54 vs 6.41 \pm 2.9, p = 0.012), significantly lower quality of life (EQ5D: 0.430 \pm 0.213 vs 0.575 \pm 0.216, p < 0.001) and significantly higher disability (ODI 52.4 \pm 16.2 vs 44.7 \pm 17, p < 0.001). [[Table 3](#)] At 3 months, patients with depression/anxiety had significantly higher back pain (3.7 \pm 2.9 vs 2.8 \pm 2.5, p < 0.001), significantly lower quality of life (EQ5D: 0.690 \pm 0.221 vs 0.785 \pm 0.174, p < 0.001), and higher disability (ODI: 29.8 \pm 20.3 vs 25.1 \pm 18.8, p = 0.013). Interestingly, the change in EQ5D was higher for patients with any depressive/anxiety disorder compared to those without (-0.252 \pm 0.250 vs -0.213 \pm 0.231, p = 0.016). [Table 4](#) At 2 years, patients with a

Table 2
Clinical Outcomes of the Cohort by Depression/Anxiety Status.

| | Total (N = 608) | No Depression or Anxiety (N = 452) | Depression or Anxiety Group (N = 156) | p value |
|--------------------------------------|-----------------|------------------------------------|---------------------------------------|---------|
| Length of Stay | 2.729 (1.798) | 2.644 (1.799) | 2.974 (1.778) | 0.048 |
| Discharge Disposition | | | | 0.010 |
| Home routine | 516 (85.3 %) | 395 (88.0 %) | 121 (77.6 %) | |
| Home with home healthcare | 32 (5.3 %) | 21 (4.7 %) | 11 (7.1 %) | |
| Post-acute or non-acute care setting | 53 (8.8 %) | 30 (6.7 %) | 23 (14.7 %) | |
| Transferred to another acute care | 4 (0.7 %) | 3 (0.7 %) | 1 (0.6 %) | |
| Readmitted within 30 Days | 11 (1.8 %) | 7 (1.5 %) | 4 (2.6 %) | 0.412 |
| Any 30 day Complication | 39 (6.4 %) | 27 (6.0 %) | 12 (7.7 %) | 0.450 |
| Any Reoperation Within 2 years | 64 (10.5 %) | 40 (8.8 %) | 24 (15.4 %) | 0.022 |

depressive/anxiety disorder had significantly higher back pain (NRS 3.8 ± 3.07 vs 3.18 ± 3.01 , $p = 0.031$), significantly lower quality of life (EQ5D: 0.430 ± 0.213 vs 0.575 ± 0.216 , $p < 0.001$) and significantly higher disability (ODI: 26.4 ± 22.1 vs 21.2 ± 19 , $p = 0.01$). We did not observe any difference between the two groups in terms of leg pain or patient satisfaction. Moreover, there was no difference in change in any of the PROs at 2 years. [Table 5](#)

3.4. Multivariable analysis

Upon multivariable logistic regression, patients with a depressive disorder were significantly less likely to achieve ODI of 20 % or lower at 3 months (OR 0.44, 95 % CI 0.21–0.94, $p = 0.03$). Moreover, non-Hispanic ethnicity was associated with higher odds (OR 2.55, 95 % CI 1.01–6.45, $p = 0.04$) while higher baseline ODI was associated with lower odds (OR 0.97, 95 % CI 0.96–0.98, $p < 0.001$) of achieving goal ODI at 3 months. Presence of an anxiety disorder was found to have no impact on odds of achieving the ODI goal at 3 months (OR 0.93, 95 % CI 0.40–2.16, $p = 0.86$). The interaction between presence of an anxiety disorder and presence of a depressive disorder was also found to be not associated with odds of achieving ODI goal at 3 months (OR 1.54, 95 % CI 0.45–5.34, $p = 0.49$) [Table 6](#)

At 2 years, presence of a depressive or anxiety disorder at the time of enrollment did not have an impact on achieving goal ODI. Factors associated with lower odds of achieving goal ODI included higher BMI (OR 0.95, 95 % CI 0.91–0.98, $p = 0.003$) and higher ODI at baseline (OR 0.96, 95 % CI 0.95–0.98, $p < 0.001$) while fusion was associated with higher odds of achieving goal ODI (OR 2.54, 95 % CI 1.40–4.62, $p = 0.002$). [Table 7](#)

4. Discussion

As per recent estimates, up to 18.1 % of the population above the age of 18 (40 million adults) in the United States is living with anxiety, while 6.7 % of the population (16.1 million adults) have major depressive disorder. Moreover, these diagnoses often co-exist; almost half of the patients with depression also have anxiety. [23] Given the high incidence of these comorbidities in the general population, it has now become standard practice in most institutions to employ measures to identify these comorbidities preoperatively using screening instruments [24].

Table 3
Baseline PROs by Depression/Anxiety Status.

| | Total (N = 608) | No Depression or Anxiety (N = 452) | Depression or Anxiety Group (N = 156) | p value |
|--|-----------------|------------------------------------|---------------------------------------|---------|
| | Baseline PROs | | | |
| Numeric Rating Scale Back Pain at Baseline | 6.685 (2.794) | 6.525 (2.839) | 7.202 (2.590) | 0.016 |
| Numeric Rating Scale Leg Pain at Baseline | 6.577 (2.837) | 6.407 (2.914) | 7.072 (2.545) | 0.012 |
| EQ5D Score at Baseline | 0.537 (0.224) | 0.575 (0.216) | 0.430 (0.213) | < 0.001 |
| ODI Score at Baseline | 46.700 (17.169) | 44.712 (17.051) | 52.435 (16.241) | < 0.001 |

ODI: Oswestry Disability Index.

Among clinical outcomes, we found that patients with depression or anxiety are more likely to have a non-routine discharge (22.4 % vs 12 %). Moreover, these patients were also more likely to require a reoperation within 2 years (15.4 % vs 8.8 %). However, the difference in length of stay, though statistically significant, was minimal between the two groups (2.97 days vs 2.64 days). Moreover, there was no difference in complication rate or 30 day readmission rate between the two groups. Our results agree with those by Menedez et al. who analyzed the National Hospital Discharge Survey (NHDS) and assessed the outcomes of patients diagnosed with depression, anxiety, schizophrenia or dementia undergoing major spine surgery. They found depression and anxiety to be independently associated with a non-routine discharge and postoperative adverse events [1]. Diebo et al. assessed the impact of comorbid mental health disorders on outcomes of patients undergoing cervical spine surgery and found similar results to ours: patients with mental disorders had a similar length of stay compared to those without, but had a higher rate of revision surgery. However, they found that patients with mental disorders also had a higher complication rate as well as a higher readmission rate [6]. Shah et al. analyzed patients undergoing surgery for spinal deformity and found that patients with mental illness were more likely to have higher complications, while reoperation rate was found to be similar to those without any mental illnesses [7]. It's important to highlight that all these studies derived their cohort from national administrative databases, which report data using ICD and CPT codes. Such databases have limitations related to coding errors [25]. Our data was derived from a national spine registry and underwent thorough review and auditing to determine accuracy of data [26].

Among PROs, our results indicate that a diagnosis of depression is associated with significantly lower odds of achieving ODI at 3 months, while it had no impact on longer term ODI. This indicates that patients with depression take longer to achieve their functional outcome goals, compared to those without depression. These results agree with those by Netto et al. who analyzed patients with and without anxiety or depression and found that at four months, patients with anxiety or depression had significantly lower VAS and ODI scores [27]. However, Adogwa et al. analyzed patients undergoing revision lumbar surgery and found that preoperative depression was associated with lower odds of achieving ODI goal at 2 years [28].

Finally, it's important to discuss why patients with anxiety or depression may suffer from adverse outcomes. Strom et al. performed a

Table 4
3-Month PROs by Depression/Anxiety Status.

| | Total | No Depression or Anxiety (N = 452) | Depression or Anxiety Group (N = 156) | p value |
|---|-----------------|------------------------------------|---------------------------------------|---------|
| 3 Month PROs | | | | |
| Numeric Rating Score Back Pain at 3 Month | 2.835 (2.499) | 2.835 (2.499) | 3.720 (2.920) | < 0.001 |
| Change in Numeric Rating Score Back Pain at 3 month | 3.671 (3.130) | 3.688 (3.026) | 3.619 (3.442) | 0.835 |
| Numeric Rating Score Leg Pain at 3 Month | 2.148 (2.777) | 2.148 (2.777) | 2.643 (3.084) | 0.079 |
| Change in Numeric Rating Score Leg Pain at 3 months | 4.356 (3.679) | 4.354 (3.676) | 4.364 (3.701) | 0.977 |
| EQ5D at 3 Months | 0.785 (0.174) | 0.785 (0.174) | 0.690 (0.221) | < 0.001 |
| Change in EQ5D at 3 Months | -0.223 (0.237) | -0.213 (0.231) | -0.252 (0.250) | 0.016 |
| ODI Score at 3 Months | 26.347 (19.320) | 25.127 (18.843) | 29.864 (20.296) | 0.013 |
| Change in ODI at 3 month | 20.369 (19.794) | 19.755 (19.890) | 22.139 (19.478) | 0.225 |

ODI: Oswestry Disability Index.

Table 5
2 Year PROs by Depression/Anxiety Status.

| | Total (N) | No Depression or Anxiety | Depression or Anxiety Group | p value |
|---|-----------------|--------------------------|-----------------------------|---------|
| 2 Year PROs | | | | |
| Numeric Rating Scale Back Pain at 2 Years | 3.353 (3.040) | 3.182 (3.012) | 3.847 (3.077) | 0.031 |
| Change in Numeric Rating Score Back Pain at 2 Years | 3.261 (3.467) | 3.607 (3.218) | 3.342 (3.410) | 0.358 |
| Numeric Rating Scale Leg Pain at 2 Years | 2.667 (3.196) | 2.607 (3.211) | 2.840 (3.157) | 0.473 |
| Change in Numeric Rating Score Leg Pain at 2 Years | 0.577 (2.623) | 1.008 (2.600) | 0.688 (2.622) | 0.105 |
| EQ5D at 2 Years | 0.537 (0.224) | 0.575 (0.216) | 0.430 (0.213) | < 0.001 |
| Change in EQ5D at 2 Years | -0.010 (0.193) | -0.012 (0.192) | -0.003 (0.195) | 0.664 |
| ODI at 2 Years | 22.512 (19.923) | 21.212 (18.964) | 26.412 (22.180) | 0.010 |
| Change in ODI at 2 Years | 23.443 (20.382) | 22.854 (20.095) | 25.194 (21.197) | 0.258 |
| Patient Satisfaction at 2 Years | | | | 0.922 |
| Surgery met my expectations | 310 (61.6 %) | 231 (61.3 %) | 79 (62.7 %) | |
| Didn't improve as much as I had hoped, but would have same surgery for same results | 103 (20.5 %) | 78 (20.7 %) | 25 (19.8 %) | |
| Surgery helped but I wouldn't have same surgery for same results | 38 (7.6 %) | 30 (8.0 %) | 8 (6.3 %) | |
| I am the same or worse after surgery | 52 (10.3 %) | 38 (10.1 %) | 14 (11.1 %) | |

ODI: Oswestry Disability Index.

systematic integrative review of factors associated with anxiety or depression among patients undergoing spinal surgery. They found that among patients with anxiety or depression, preoperative and post-operative symptoms were regulated by an interaction of five key factors that included lack of information, disability, return to work, pain and mental well-being [8]. Thus, it is imperative that adequate and appropriate preoperative counseling is performed for such patients so that, it may be possible to optimize outcomes for patients with anxiety or depression, undergoing spinal surgery. This preoperative assessment should employ an established comprehensive psychological evaluation tool; the surgeon should discuss the results of this assessment explicitly

with the patient, informing them of the risk of poor outcomes that they may be at risk of. Finally, if this assessment indicates that these patients may be at risk of sub-optimal outcomes, cognitive and behavioral interventions should be discussed with the patient and implemented. Several studies have now demonstrated the utility and efficacy of such combined pre- and post-operative rehabilitation based interventions for these patients [29–33].

5. Limitations

Our study has some limitations. First, a diagnosis of a depressive or

Table 6
Multivariable Model for Achieving 20 % or less ODI at 3-Months.

| | Odds Ratio | Lower 95 % | Upper 95 % | p-Value |
|--|------------|------------|------------|----------------|
| Age | 1.01 | 0.99 | 1.03 | 0.40 |
| Gender - Male vs Female | 1.05 | 0.70 | 1.58 | 0.81 |
| Ethnicity: Non Hispanic vs Hispanic | 2.55 | 1.01 | 6.45 | 0.04 |
| BMI | 0.98 | 0.95 | 1.02 | 0.33 |
| Symptom Duration : < 3 Months vs > 3 Months | 1.29 | 0.38 | 4.40 | 0.68 |
| Insurance Status : Private vs Medicare/Medicaid | 1.24 | 0.78 | 1.96 | 0.36 |
| Education - < High School vs College | 0.52 | 0.15 | 1.82 | 0.30 |
| Education - High School vs College grad | 0.85 | 0.55 | 1.33 | 0.48 |
| Education - Post-graduate vs College grad | 1.06 | 0.62 | 1.83 | 0.82 |
| Smoker | 1.32 | 0.66 | 2.67 | 0.43 |
| Diabetes | 0.88 | 0.51 | 1.53 | 0.65 |
| Ambulation Status - Not Independent VS Independent | 1.26 | 0.66 | 2.38 | 0.48 |
| ASA - 3 or 4 vs 1 or 2 | 0.90 | 0.60 | 1.36 | 0.61 |
| Length of Stay | 0.99 | 0.87 | 1.13 | 0.90 |
| Surgical Group - Decompression Alone VS Decompression and Fusion | 1.26 | 0.73 | 2.16 | 0.408 |
| ODI at Baseline | 0.97 | 0.96 | 0.98 | < 0.001 |
| Depression | 0.44 | 0.21 | 0.94 | 0.03 |
| Anxiety | 0.93 | 0.40 | 2.16 | 0.86 |
| Depression * Anxiety (Interaction) | 1.54 | 0.45 | 5.34 | 0.49 |

BMI: Body Mass Index; VA: Veterans Affairs; ASA: American Society of Anesthesiologists; ODI: Oswestry Disability Index.

Table 7
Multivariable Model for Achieving 20 % or less ODI at 2 years.

| | Odds Ratio | Lower 95 % | Upper 95 % | p-Value |
|--|------------|------------|------------|----------------|
| Age | 1.03 | 1.01 | 1.06 | 0.01 |
| Gender - Male vs Female | 1.25 | 0.81 | 1.93 | 0.32 |
| Ethnicity: Non Hispanic vs Hispanic | 1.42 | 0.52 | 3.85 | 0.491 |
| BMI | 0.95 | 0.91 | 0.98 | 0.003 |
| Symptom Duration : < 3 Months vs > 3 Months | 2.98 | 0.71 | 12.55 | 0.13 |
| Insurance Status : Private vs Medicare/Medicaid | 1.41 | 0.86 | 2.31 | 0.17 |
| Education - < High School vs College | 0.79 | 0.49 | 1.26 | 0.62 |
| Education – High School vs College grad | 0.73 | 0.21 | 2.58 | 0.32 |
| Education – Post-graduate vs College grad | 1.45 | 0.82 | 2.56 | 0.20 |
| Smoker | 1.75 | 0.81 | 3.78 | 0.15 |
| Diabetes | 0.87 | 0.49 | 1.57 | 0.65 |
| Ambulation Status - Not Independent VS Independent | 0.91 | 0.46 | 1.80 | 0.78 |
| ASA - 3 or 4 vs 1 or 2 | 0.95 | 0.61 | 1.46 | 0.81 |
| Length of Stay | 0.96 | 0.85 | 1.09 | 0.54 |
| Surgical Group - Decompression Alone VS Decompression and Fusion | 2.54 | 1.40 | 4.62 | 0.002 |
| ODI at Baseline | 0.96 | 0.95 | 0.98 | < 0.001 |
| Depression | 0.78 | 0.37 | 1.62 | 0.49 |
| Anxiety | 0.67 | 0.28 | 1.58 | 0.35 |
| Depression * Anxiety (Interaction) | 3.50 | 0.99 | 12.39 | 0.06 |

BMI: Body Mass Index; VA: Veterans Affairs; ASA: American Society of Anesthesiologists; ODI: Oswestry Disability Index.

anxiety disorder was made using the electronic medical record at the time of enrollment into registry, thus we did not assess the severity or the exact DSM-V type of anxiety or depressive disorder at the time of surgery. Thus, the distinction between active depression or active anxiety and a history of anxiety or depression was not made and so some selection bias may have been introduced. Along the same lines, we did not document concurrent treatment of anxiety or depression, and did not assess the severity of depressive or anxiety symptoms at follow-up. Thus we were limited in our capacity to study how such psychological comorbidities evolve after surgery and if that could have any impact on functional outcomes of patients.

6. Conclusion

Using data from a national spine registry, we found that patients with an anxiety or a depressive disorder may achieve optimum long term functional outcomes after undergoing surgery for degenerative low grade spondylolisthesis. However, such patients may still be more likely to have a non-routine discharge and require reoperation within 2 years.

Credit authors statement

O.K. – Conceptualization and design, data collection, analysis, and drafting of manuscript

K.S.– Conceptualization and design, data collection, analysis, and drafting of manuscript

M.A.A.– Data collection, analysis, and drafting of manuscript

Y.U.Y. – Reviewing and revising original draft

K.F. – Reviewing and revising original draft

J.J.K. – Reviewing and revising original draft

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E.F.B – Study supervision, reviewing and revising original draft

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