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Predicting Acute Changes in Depressive Symptoms Following Lumbar Decompression

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ABSTRACT

Background: While depressive symptoms improve for most patients following minimally invasive lumbar decompression (MIS LD), for some, symptoms may worsen. This study aimed to investigate predictors of change in depressive symptoms in the short-term postoperative period following MIS LD.

Methods: We retrospectively analyzed a prospective surgical database for patients undergoing primary MIS LD procedures from 2016 to 2020. Preoperative pain (visual analog scale back and leg) scores were recorded, and the 9-Item Patient Health Questionnaire (PHQ-9) was administered at the preoperative and postoperative (6 weeks, 12 weeks, 6 months, and 1 year) timepoints. Patients were grouped into 1 of 3 categories of depression severity based on preoperative PHQ-9 scores: minimal (0–4), mild (5–9), and moderate to severe (10–27). Postoperative change in depressive symptoms was calculated by determining differences from baseline scores to scores at 6 weeks, 12 weeks, and 6 months. Analysis of demographics, perioperative characteristics, and spinal pathologies was conducted using χ^2 test. Significant factors contributing to postoperative changes in depression were analyzed using multiple linear regression analysis. Significance was set at $P = 0.05$.

Results: The 216 patients included had a mean age of 48 years, and a majority were men (70.4%). Most patients had a preoperative diagnosis of spinal stenosis (90.3%) or herniated nucleus pulposus (69.9%). Univariate analysis identified age, ethnicity, insurance, and diabetes as significant variables among depression severity groups. Patients demonstrated significant improvements in depressive symptoms at all postoperative timepoints ($P < 0.001$). Multivariate analysis identified several significant predictors of postoperative change in PHQ-9, which included moderate to severe preoperative depression for all postoperative timepoints (all $P \leq 0.038$), mild preoperative depression for 6 weeks and 12 weeks (both $P \leq 0.029$), and private insurance ($P = 0.002$) and smoking status ($P = 0.047$) at 12 weeks.

Conclusion: Depression improved at all postoperative timepoints following LD. Insurance type, smoking status, and preoperative depression severity were all identified as significant predictors of postoperative changes in depressive symptoms.

Clinical Relevance: This study explores predictors of changes in depressive symptoms following LD.

Level of Evidence: 3.

Lumbar Spine

Keywords: depression, 9-Item Patient Health Questionnaire (PHQ-9), lumbar decompression (LD), postoperative, acute

INTRODUCTION

With more than 46.6 million US adults affected by mental health disorders, the prevalence of these illnesses has greatly increased over the years.[1] One of the most widely treated and clinically researched mental health disorders is depression. Distinguished by low mood and loss of interest or pleasure in usually enjoyed activities, depression may be a risk factor for greater morbidity and lower quality of life in surgical patients.[2] For spine surgery patients specifically, studies report that postoperative depressive symptoms correlate with worse clinical outcomes such as pain and disability.[3–5] As such, the Patient Health Questionnaire-9 (PHQ-9) has been extensively used to gauge depressive symptoms for this surgical population.[6]

Most patients undergoing spine surgery report improvements in depressive symptoms following their procedures;[7] however, there is a subset for which these depressive symptoms are exacerbated after surgery. In fact, spinal procedures are reported to have the greatest risk of new onset postoperative depressive symptoms in comparison to other surgical fields.[8] Yet, there remains a gap in knowledge as to why some patients suffer from these detrimental mental health outcomes while others do not.

Although studies have analyzed risk factors for adverse surgical outcomes in terms of medical complications, few have focused on recognizing predictors of worsening depression after surgery.[9,10] With a greater awareness of specific predictors of postoperative changes in mental health, physicians will be able to better identify patients with a greater likelihood of affliction and amend their preoperative counseling. In fact, Chuang et al reported low occurrences of anxiety in patients who were educated prior to their cervical disc herniation surgeries.[11] In a similar sense, by identifying the factors that mediate depression in specific spinal procedure types, surgeons may utilize methods such as preoperative education to create individualized treatment plans and optimize mental and physical outcomes.

One particular spinal procedure of interest is lumbar decompression (LD), which is widely used as a highly effective treatment of lumbar disc herniations and spinal stenosis.[12] These conditions are generally associated with chronic lower back pain, which is highly comorbid with depression.[13,14] As such, exploration of characteristics predictive of postoperative changes in depression may be particularly relevant for this commonly utilized procedure in a susceptible population. Therefore, our study aims to investigate and establish predictors of short-term changes in depressive symptoms in the postoperative period following LD.

METHODS

Patient Population

Institutional Review Board approval (ORA# 14051301) was granted prior to beginning this study, and all included patients provided informed written consent. Eligible procedures from 2016 to 2020 were retrospectively reviewed in a prospectively maintained surgical database. Patients were included in this study if they underwent an elective primary, single, or multilevel minimally invasive LD. Patients who underwent surgery for infectious, malignant, or traumatic etiologies were not included in this study, as well as patients failing to complete a preoperative PHQ-9. All procedures were performed at a single institution by a senior attending physician.

Data Collection

All included patients had their demographic and perioperative information collected for this study. Variables collected for patient demographics included age, gender, body mass index (BMI; in kg/m^2), ethnicity, smoking status, and type of insurance. Perioperative information included both preoperative and intraoperative variables such as diabetic status, American Society of Anesthesiologists physical status classification, Charlson Comorbidity Index, back and leg pain scores as measured using a visual analog scale, preexisting spinal pathology, operative time, and number of lumbar spinal levels decompressed.

The primary outcome of interest for this study was the PHQ-9, which was collected at the preoperative timepoint and acute postoperative timepoints (6 weeks, 12 weeks, and 6 months). Worsening depressive symptoms were identified by calculating the delta depression score (postoperative depressive score − preoperative depressive score) and were defined as any delta depression value >0.

Statistical Analysis

All statistical analyses were performed using Stata 16.0 (StataCorp, College Station, TX). Prior to performing any analysis, well-established cutoff points were utilized to categorize patients into the following 3 groups based on their preoperative PHQ-9 score: minimal (0–4), mild (5–9), and moderate to severe (10–27).[15] Descriptive statistics were performed for all demographic, preoperative, and intraoperative variables. Univariate analysis of demographic, perioperative variables, and spinal pathologies was assessed using χ^2 analysis. Overall levels of improvement in PHQ-9 scores from preoperative baseline were determined using a paired Student *t* test at each postoperative timepoint. Multiple regression analysis was used to identify significant predictors of acute worsening of postoperative depression following LD. A significance threshold of $P \leq 0.05$ was used across all statistical tests.

RESULTS

Patient Characteristics

Inclusion and exclusion criteria identified a total of 216 patients who were eligible for this study. A total of 109 patients were categorized as having minimal depressive symptoms, 64 with mild depressive symptoms, and 43 with moderate to severe depressive symptoms. The patient cohort had a mean age of 48.5 ± 13.0 years; most patients were men (70.4%) men and were not obese (54.6%) (BMI <30 kg/m^2). Univariate analysis demonstrated a significant difference in age ($P = 0.045$), BMI ($P = 0.031$), ethnicity ($P < 0.001$), diabetic status ($P = 0.050$), and insurance collected ($P = 0.003$) between all depression subgroups (Table 1).

Table 1. Patient demographics by depression symptom subgroup.

Demographic	Minimal (n = 109)	Mild (n = 64)	Moderate to Severe (n = 43)	P Value[a]
Age, y				0.045
<50	49.5% (54)	40.6% (26)	65.1% (28)	
≥50	50.5% (55)	59.4% (38)	34.9% (15)	
Gender				0.090
Women	22.9% (25)	37.5% (24)	34.9% (15)	
Men	77.1% (84)	62.5% (40)	65.1% (28)	
Body mass index				0.031
<30 kg/m^2	63.3% (69)	43.7% (28)	48.8% (21)	
≥30 kg/m^2	36.7% (40)	56.3% (36)	51.2% (22)	
Race				<0.001
Nonwhite	15.7% (17)	31.2% (20)	51.2% (21)	
White	84.3% (91)	68.7% (44)	48.8% (20)	
Smoking status				0.408
Nonsmoker	92.7% (101)	92.2% (59)	86.1% (37)	
Smoker	7.3% (8)	7.8% (5)	13.9% (6)	
Diabetic status				0.050
Diabetic	95.4% (104)	85.9% (55)	95.3% (41)	
Nondiabetic	4.6% (5)	14.1% (9)	4.7% (2)	
American Society of Anesthesiologists score				0.953
<2	86.2% (94)	87.1% (54)	88.1% (37)	
≥2	13.8% (15)	12.9% (8)	11.9% (5)	
Charlson Comorbidity Index score				0.745
<1	67.1% (55)	69.9% (28)	67.7% (21)	
≥1	32.9% (25)	39.1% (18)	32.3% (10)	
VAS back				0.267
<7	57.1% (60)	44.3% (27)	50.0% (21)	
≥7	42.9% (45)	55.7% (34)	50.0% (21)	
VAS leg				0.159
<7	64.8% (68)	59.0% (36)	47.6% (20)	
≥7	35.2% (37)	41.0% (25)	52.4% (22)	
Insurance				0.003
Medicare/Medicaid	4.6% (5)	1.5% (1)	4.7% (2)	
Workers' compensation	8.3% (9)	25.0% (16)	32.6% (14)	
Private	87.2% (95)	73.4% (47)	62.8% (27)	

Abbreviation: VAS, visual analog scale.
Note: Data presented as (%) n.
[a]P value calculated using χ^2 test.

Perioperative Characteristics

A majority of the patient cohort had a spinal pathology of spinal stenosis (90.3%) and underwent an LD at a single level (81.5%) with an average operative time of 45.2 ± 17.7 minutes, estimated blood loss of 26.4 ± 7.4 mL, and length of stay of 7.0 ± 11.9 hours. No significant differences in perioperative variables were demonstrated between groups (Table 2).

Outcome Measurements

Depression severity showed an overall improvement across all groups at the 6-week (P < 0.001), 12-week

Table 2. Perioperative characteristics by depressive symptom subgroup.

Characteristics	Minimal (n = 109)	Mild (n = 64)	Moderate to Severe (n = 43)	P Value[a]
Spinal pathology				
Herniated nucleus pulposus	71.6% (78)	62.5% (40)	76.7% (33)	0.102
Foraminal stenosis	58.7% (64)	57.8% (37)	72.1% (31)	0.254
Spinal stenosis	89.0% (97)	92.2% (59)	90.7% (39)	0.787
Decompression				0.212
Single level	77.8% (84)	85.7% (54)	88.4% (38)	
Multilevel	22.2% (24)	14.3% (9)	11.6% (5)	
Operative time, min	44.7 ± 16.3	45.5 ± 19.5	46.1 ± 19.0	0.907
Estimated blood loss, mL	26.7 ± 7.9	26.2 ± 6.9	26.1 ± 5.9	0.863
Length of stay, h	7.4 ± 13.6	6.8 ± 9.5	6.7 ± 10.4	0.927

Note: Data presented as (%) n or mean ± SD.
[a]P value calculated using χ^2 test or analysis of variance.

Table 3. Improvement in PHQ-9 after lumbar decompression.

Timepoint	PHQ-9 Score, Mean ± SE	*P* Value[a]
Preoperative	6.1 ± 0.5	–
6 wk	3.3 ± 0.4	<0.001
12 wk	3.9 ± 0.6	<0.001
6 mo	3.8 ± 0.5	<0.001

Abbreviation: PHQ-9, Patient Health Questionnaire-9.
[a]*P* values calculated using paired *t* test.

($P < 0.001$), and 6-month ($P < 0.001$) postoperative timepoints (Table 3). Multiple linear regression analysis demonstrated a number of significant risk factors for acute worsening in postoperative depression scores. Moderate to severe preoperative depressive symptoms were a significant factor for predicting postoperative change in PHQ-9 scores at 6 weeks (coefficient, ß: −8.13; 95% CI [−10.46, −5.80]; $P < 0.001$), 12 weeks (coefficient, ß: –10.08; 95% CI [–14.04, –6.11]; $P < 0.001$) and 6 months (coefficient, ß: –4.63; 95% CI [–9.00, –0.27]; $P = 0.038$, Table 4). Mild preoperative depressive symptoms were a significant predictor at 6 weeks (coefficient, ß: –4.48; 95% CI [–6.68, –2.93]; $P < 0.001$) and 12 weeks (coefficient, ß: –3.57; 95% CI [–6.77, –0.37]; $P = 0.029$) but not at 6 months. At the 12-week timepoint, private insurance (coefficient, ß: –5.48; 95% CI [–8.94, –2.04]; $P = 0.002$) and active smoking (coefficient, ß: 3.91; 95% CI [0.05, 7.77]; $P = 0.047$) were significant predictors of PHQ-9 score change (Table 4).

DISCUSSION

Depression is a common mental health disorder that has been associated with less favorable outcomes both before and after spine surgery. A number of studies have examined the influence of preoperative depression on postoperative outcomes following spine surgery.[16–18] However, Rahman et al[19] demonstrated that changes in postoperative mental health may actually have a greater impact on outcomes of spine surgery than preoperative depression scores. While most patients tend to report improvements in depressive symptoms following spine surgery, a smaller subset may actually experience worsening of these symptoms. This study is the first to assess predictors specifically for acute postoperative changes in depressive symptoms in patients undergoing LD surgery.

Our results demonstrated that a number of patient demographics varied significantly on the basis of preoperative depression. Specifically, age, BMI, race, diabetes status, and insurance type were significantly associated with preoperative depression status. The relationship between obesity and depression has been well established in the literature[20,21] and may likely involve a bidirectional interplay of mechanical, metabolic, and psychosocial factors. Interestingly, not only is age a risk factor for depression, but age-dependent effects may also modulate the effects of a number of other risk factors for depression.[22,23] The relationship between diabetes and depression is also supported by previous literature.[24] None of the preoperative spinal pathologies or operative variables assessed in our study were significantly associated with severity of preoperative depressive symptoms.

Overall, patients in our study reported significant improvements in depressive symptoms at all short-term timepoints. These results are in line with those of previous studies demonstrating significant improvements in PHQ-9 scores following lumbar spine procedures, including LD.[25,26] Further analysis of postoperative improvement in depressive symptoms helped characterize factors that may predict such changes in mental health. Our multiple regression analysis revealed a number of factors that significantly predicted acute changes in depressive symptoms following LD surgery. Preoperative severity of depressive symptoms, as measured by PHQ-9, was the only variable that consistently predicted these changes at all short-term timepoints. Specifically, preoperative PHQ-9 scores of increasing

Table 4. Significant predictors of change in postoperative depression.

Variable	Coefficient, ß	SE	95% CI		*P* Value[a]
6 wk					
Mild PHQ-9	−4.48	0.94	−6.68	−2.93	<0.001
Moderate to severe PHQ-9	−8.13	1.17	−10.46	−5.80	<0.001
12 wk					
Mild PHQ-9	−3.57	1.59	−6.77	−0.37	0.029
Moderate to severe PHQ-9	−10.08	1.97	−14.04	−6.11	<0.001
Private insurance	−5.49	1.72	−8.94	−2.04	0.002
Smoking	3.91	1.92	0.06	7.78	0.047
6 mo					
Moderate to severe PHQ-9	−4.63	2.16	−9.00	−0.27	0.038

Abbreviation: PHQ-9, Patient Health Questionnaire-9.
[a]*P* values calculated using multiple linear regression analysis.

severity actually demonstrated an inverse relationship with increases in postoperative depression. While this result may initially seem surprising, we theorize that it may be related to the relative "room" a patient has for improvement or worsening of depressive symptoms.

Previous studies have supported the validity of PHQ-9 and demonstrated minimal floor and ceiling effects for this measure.[27,28] Specifically, authors have cited the low numbers of patients reaching maximum PHQ-9 scores as indications that no such ceiling effects are at play. Indeed, no patients in our study scored the maximum 27 points on PHQ-9 at any of the timepoints assessed. However, it is possible that the nature of the PHQ-9 may belie a more subtle type of ceiling effect. Certain questions address a patient's experience of depression but limit the response. Consider, for example, a patient who may respond to several questions as experiencing the symptoms all the time. Even if these symptoms significantly worsen in their severity over time, the patient's score may not significantly increase since the questions that apply to them are already essentially "maxed out." Therefore, perhaps patients in our study with more severe preoperative symptoms had already "saturated" their applicable PHQ-9 questions, while those with lower preoperative scores had little room to worsen but significant potential to increase their depression scores.

The relationship between preoperative depression and postoperative outcomes in spine surgery has been examined by a number of previous studies. In their study of LD patients, Merrill et al[29] demonstrated that patients with more severe preoperative depression tended to have less favorable postoperative outcomes in terms of pain, disability, physical function, and depression. Interestingly, however, more depressed patients in their study actually demonstrated greater improvements in physical function than those that were not depressed. These results may be in line with our finding that patients with more severe preoperative symptoms may have more potential to experience significant improvements.

In addition to preoperative depressive symptoms, 2 other significant predictors were identified for changes in PHQ-9 at the 12-week timepoint only. Specifically, smoking status was directly associated with postoperative increases in PHQ-9, while private health insurance demonstrated a protective effect against worsening depression. The association between depression and tobacco use has been well described in the literature and is likely quite complex.[30,31] Furthermore, current smoking has been shown to negatively affect the outcomes of spinal procedures in terms of increased rates of pseudoarthrosis and postoperative infection.[32] Although not well studied, it is thus plausible to suggest that the established relationship between smoking and depression may suggest a relationship between postoperative depression and pseudoarthrosis and/or postoperative infection following spinal surgery.

In contrast to smoking, having private health insurance demonstrated an inverse relationship with changes in PHQ-9 at 12 weeks after LD. These effects may be indicative of increased access to health care and other services afforded by private insurance, as well as generally higher levels of socioeconomic and employment status that may be enjoyed by those with private insurance. Few studies have investigated the direct impact of insurance status on postoperative depression; however, disc herniation studies have associated a number of factors with improvement in patient-reported outcomes including nonsmoking status, nonworkers' compensation status, being insured, and not being depressed.[33]

Workers' compensation was more common in the more severely depressed patients in our cohort than in those with lower levels of preoperative depressive symptoms. Workers' compensation status has previously been associated with decreased rates of returning to work after lumbar spine surgery.[34] Furthermore, among patients receiving workers' compensation benefits, depression has been demonstrated to correlate with worse outcomes following lumbar spine surgery and lower rates of returning to work in particular.[35]

Our results regarding demographic risk factors for worsening depression are similar to those of Chapin et al's[36] study of satisfaction following lumbar spine surgery. These authors determined that depression, smoking, and employment status were all significant risk factors for decreased satisfaction following lumbar spine surgery. Considering the results of published literature as well as more "common sense" understanding, it is not difficult to imagine that the demographic factors we identified may be related to changes in postoperative depression. However, it is more challenging to explain why some of these factors reached the level of statistical significance at the 12-week timepoint but not at 6 weeks or 6 months. Understanding and exploring these more subtle differences in the postoperative recovery process represent a valuable opportunity for future research. Nevertheless, this current work establishes the importance of preoperative depression for predicting and understanding changes in depressive symptoms after LD surgery.

Limitations

The methodology of this study introduces several potential limitations. First, all procedures were performed by the same attending surgeon at a single academic institution, which may limit the generalizability of our results and cause bias that limits external validity. Second, the self-reported nature of the primary outcome variable introduces the potential for response bias. However, depressive symptoms arguably are an inherently subjective experience, and no well-established, objective clinical measure of these symptoms exist. Third, we used an acute timeframe to determine significant predictors of depressive symptom change. A shorter period may rely more heavily on larger changes in primary outcomes and limits our ability to detect smaller changes. Finally, our patients grouped into the moderate to severe category did not have a diagnosis confirmed by a licensed professional. Although the PHQ-9 may help capture potentially severely depressed individuals, future studies would benefit from determining an official diagnosis.

CONCLUSION

Overall, patients in this study significantly improved following LD with regard to their levels of depressive symptoms. For those who experienced worsening of depressive symptoms following LD, preoperative PHQ-9 scores predicted this adverse outcome at all short-term postoperative timepoints, while smoking status and insurance type did so more intermittently. These factors may be important for physicians to understand in order to identify those patients who may be at risk for worsening depression following spine surgery.

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