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The Effect of Preoperative Mental Health Status on Outcomes After Anterior Cervical Discectomy and Fusion

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ABSTRACT

Background: The effect of preoperative mental health on outcomes after anterior cervical discectomy and fusion (ACDF) is of increasing interest. The purpose of this study was to utilize patient-reported outcome measures (PROMs) to compare outcomes after ACDF in patients with and without poor mental health. We hypothesized that patients with worse baseline mental health would report worse outcomes after surgery.

Methods: Patients undergoing ACDF for degenerative cervical spondylosis with at least 12 months of follow-up were included. Outcomes collected before and after surgery included the RAND-36, Neck Disability Index (NDI), EuroQol 5-dimension (EQ-5D), and Single Assessment Numeric Evaluation (SANE) score.

Results: Seventy-one patients were included and assigned to the depression or nondepression group based on baseline mental health. The depression group had worse baseline preoperative scores across all PROMs: NDI (44.2 vs 36.8, $P = 0.05$), RAND (1511.4 vs 2198.18, $P < 0.001$), EQ-5D (12.55 vs 10.14, $P < 0.001$), and SANE (56.3 vs 72.9, $P < 0.001$). Postoperatively, the depression group had worse scores at the final follow-up for RAND (2242.8 vs 2662.2, $P = 0.03$) and SANE (71.5 vs 80.8, $P = 0.02$). Both groups experienced improvements with ACDF across all PROMs. The changes in each PROM were not statistically significant between groups. There were no statistically significant differences in the percentage of patients achieving the minimal clinically important difference across PROMs.

Conclusion: This study is the first to utilize the RAND-36, EQ-5D, NDI, and SANE scores to assess preoperative mental health and its effect on postoperative outcomes after ACDF. While poor preoperative mental health status yielded significantly worse baseline and postoperative outcomes scores, patients experienced significant improvement in symptoms after ACDF.

Level of Evidence: 2.

Clinical Relevance: Clinicians should be aware of the effects of poor mental health status on clinical outcomes in patients undergoing anterior cervical fusion, but can still expect significant clinical improvements after surgery.

Cervical Spine

Keywords: depression, mental health, ACDF, cervical, patient-reported outcomes, SANE

INTRODUCTION

Anterior cervical discectomy and fusion (ACDF) is commonly utilized in the surgical management of degenerative cervical radiculopathy and radiculopathy. ACDF has been associated with improvement of symptoms and patient quality of life with long-term follow-up and is often referenced as the "gold standard" in the treatment of degenerative cervical pathology.[1,2] Despite improvements in health-related quality of life for most patients, improvement is not universal.[3] Recent interest has turned to evaluate the effect of preoperative mental health regarding outcomes of ACDF. Several recent large database studies have found an increased risk of adverse outcomes and healthcare costs following ACDF in patients with a preoperative mental health disorder diagnosis[4,5]; however, there is a lack of consensus regarding the clinical impact of mental health and ACDF outcomes.[6]

There have been several studies in recent years utilizing patient-reported outcome measures (PROMs) to evaluate pre-existing mental health disorders and ACDF outcomes.[4,6–10] There are a variety of instruments available for assessing PROMs, and many have been validated in spine surgery. The RAND-36 survey, Short Form-12, Neck Disability Index (NDI), visual analog score, EuroQol 5-dimension (EQ-5D), Physical Component Score (PCS-12), Mental Component Score (MCS-12), and many others have been used to evaluate ACDF patients.[3,6,7,10] One instrument that has grown

in popularity in other surgical specialties is the Single Assessment Numeric Evaluation (SANE). The SANE is a one-question PROM instrument that assesses the functional level by having the patient rate the affected body part from zero to 100, with 100 being completely normal.[11,12] The SANE has been validated in various areas of orthopaedics[11–15] but has not yet been utilized in spine surgery.

Therefore, the purpose of this study was to utilize legacy PROMs and the SANE score to compare outcomes following ACDF in patients with and without depression. Our hypothesis was that patients with worse baseline mental health would report worse outcomes following surgical intervention. Additionally, we hypothesized that surgical intervention would improve patient-reported mental health and that improvements in pain would be related to improvements in mental health.

METHODS

Data Collection and Study Design

This was a retrospective cohort study on adult patients who met indications for an ACDF for degenerative cervical pathology at one institution. All surgeries were performed by fellowship-trained spine surgeons. All included patients were older than 18 years at the time of surgery and had at least 12 months of follow-up. Medical records were reviewed to collect demographic data, including age, sex, body mass index, medical comorbidities, and tobacco use.

Patients were evaluated preoperatively and postoperatively using the NDI, EQ-5D, SANE, and the RAND-36 assessment tools for health-related quality of life. The RAND-36 was primarily used to determine the overall mental health status of patients using the 6 categorical mental health domains within the instrument. These mental health domains are scored on the persistence and significance of symptoms. Higher scores in these domains indicate a lower impact of depressive or anxious symptoms. The mean of these domains was calculated to yield a continuous score from 0 to 100. Subjects were classified as depressed if the mean of the 6 mental health domains was less than 60.0, which indicates that self-reported depression or anxiety symptoms are present the majority of the time. All other patients were classified as not depressed. Additionally, the Pain/Discomfort Intensity scale domain (0 = no pain; 5 = severe pain) from the NDI was utilized as a singular surrogate for pain severity, before and after surgery.

Statistical Analysis

Continuous variables were analyzed using a paired *t* test, and categorical data were compared using a Pearson χ^2 test. Demographic data were analyzed with descriptive statistics. Statistical analysis was performed utilizing Microsoft Excel (Redmond, WA) and Open Source Epidemiologic Statistics for Public Health (www.openepi.com). The minimal clinically important difference (MCID) for the PROMs was determined using a previously described method.[14]

RESULTS

There were 71 subjects who met the inclusion criteria for this study. The average age was 50.8 years, and the cohort was 51.4% male. The baseline RAND composite mental health domain average was 68.79 (range: 16.33–100). The mean baseline EQ-5D anxiety/depression domain score was 1.73 (range: 1–5). Twenty-three patients fell below the threshold for depression (RAND composite <60) preoperatively. There were no statistically significant differences between the nondepressed and depressed patient groups, although there were slightly lower rates of hyperlipidemia and hypertension in the depressed group (Table 1).

Preoperatively, subjects in the depression group demonstrated lower scores across all PROMs at baseline. The baseline in the depressed group had a mean RAND composite of 1511.4 vs 2198.18 in the nondepressed group ($P < 0.001$). The NDI in the depressed group was 44.2 vs 36.8 in the nondepressed group ($P = 0.04$). Depressed subjects showed a mean EQ-5D of 12.55 vs 10.14 in the nondepressed group ($P < 0.001$). Additionally, SANE scores were 56.3 and 72.9 in the depressed and nondepressed groups, respectively ($P < 0.001$).

Postoperatively, patients in the depressed group continued to report lower scores across all evaluated PROMs at the final follow-up, though this finding was only statistically significant for the RAND and SANE. The final postoperative RAND scores were 2242.8 and 2662.2 in the depressed and nondepressed groups, respectively ($P = 0.03$). Patients in the depressed group reported a mean NDI of 25.0 vs 18.9 in the nondepressed group ($P > 0.05$). Postoperative EQ-5D scores were 8.9 and 7.9 in the depressed and nondepressed groups, respectively ($P > 0.05$). The postoperative SANE score at the final follow-up was 71.5 in the depressed group, which was significantly lower than in the nondepressed group (80.9, $P = 0.02$).

Table 1. Demographics and preoperative data for the depressed and nondepressed groups.

Characteristic	Depression Cohort (n = 23)	Nondepression Cohort (n = 49)	P
Age, y, mean	48.4	53.2	0.062
Sex, female)	52.2%	46.9%	0.802
BMI, mean	31.1	30.1	0.673
Comorbidities			
Diabetes	13.0%	24.5%	0.358
Hypertension	26.1%	53.1%	**0.043**
Hyperlipidemia	13.0%	51.0%	**0.002**
Rheumatologic disorder	17.4%	16.3%	0.786
Alcohol abuse	13.0%	10.2%	0.721
Tobacco abuse	13.0%	8.2%	0.515
ACDF			
1-level	47.8%	40.8%	0.575
2-level	43.5%	38.8%	0.704
3-level	8.7%	20.4%	0.315

Abbreviations: ACDF, anterior cervical discectomy and fusion; BMI, body mass index.
Data presented as % unless otherwise noted. Boldface indicates statistically significant findings.

Both groups demonstrated improvements in all PROMs following ACDF, and there were no statistically significant differences in the percentage of patients achieving the MCID for SANE, RAND-36, EQ-5D, or NDI. The absolute change between preoperative and postoperative scores for the depressed and nondepressed groups were 731.4 vs 466.7 (P = 0.09) for the RAND, 19.2 vs 17.8 (P = 0.74) for the NDI, 3.6 vs 2.25 (P = 0.08) for the EQ-5D, and 15.2 vs 7.9 (P = 0.17) for the SANE.

For all patients, the average RAND mental health composite improved to 77.49 after surgery, which was significantly better than preoperatively (P = 0.0001). Similarly, the average anxiety/depression domain of the EQ-5D significantly improved to 1.45 postoperatively (P = 0.011). The number of patients meeting the threshold for depression on the RAND decreased to 12 (19.9%) after surgery, which was also statistically significant (P = 0.03). The baseline Pain/Discomfort Intensity domain from the NDI was 2.08 (range, 1–5) for all patients and improved significantly to 0.9 after ACDF (P < 0.0001) (Table 2).

The average preoperative RAND anxiety/depression score in the depressed group was 48.3, compared to 78.6 in the nondepressed group (P < 0.0001). Average EQ-5D anxiety/depression was also significantly lower in the depressed group at baseline (2.4 vs 1.4, P < 0.0001). After surgery, the mental health RAND composite improved significantly in both groups: in the depressed group, it improved to 66.8 (P = 0.001), and in nondepressed group, it improved to 82.6 (P = 0.05). These postoperative findings were also significantly different when compared between the groups (P = 0.0001). The EQ-5D anxiety/depression domain also significantly improved in the depressed group, with the depressed group experiencing a significantly larger improvement (0.6 vs 0.1, P = 0.04). The average change in RAND score was statistically significantly larger in the depressed group compared to the nondepressed group (18.4 vs 4.0, P = 0.001). The MCID for the RAND anxiety/depression composite score was calculated to be 9.1; overall, 38 patients (54%) in this study met the MCID for the RAND mental health composite domain. Sixteen of those patients (69.9%) were in the baseline depressed group, compared to 45.8% of the nondepressed group (P = 0.06). Baseline pain intensity was neither significantly worse in the depressed group (2.3 vs 1.9, P = 0.17), nor was pain intensity worse after surgery in the depressed group (1.0 vs 0.8, P = 0.34), though pain improved significantly for both groups after surgery. These data are summarized in Table 3.

Table 2. Mean scores on the patient-reported mental health measures (RAND and EQ-5D) and pain intensity (NDI), with comparisons before and after teh operation.

	Mean			
Outcome Measure	**Preoperative**	**Postoperative**	**Δ**	***P***
RAND: MCS overall	68.79	77.49	8.70	**0.0001**
EQ-5D: MHD overall	1.73	1.45	0.28	**0.01**
Pain intensity (NDI) overall	2.08	1.04	1.18	**<0.0001**

Abbreviations: EQ-5D, EuroQol 5-dimension; MCS, Mental Composite Score; MHD, mental health domain; NDI, Neck Disability Index.
Boldface indicates statistically significant findings.

Table 3. Results of the patient-reported mental health measures (RAND and EQ-5D) and pain intensity (NDI), with comparisons between depressed and nondepressed groups, as well as within both groups before and after the operation.

Outcome Measure	Depression Cohort (n = 23)	Nondepression Cohort (n = 49)	P
RAND			
MCS preoperative	48.34	78.56	**<0.0001**
MCS postoperative	66.78	82.63	**<0.001**
Mean Δ	8.70	4.04	**0.001**
P	**0.0001**	**0.04**	
EQ-5D			
MHD preoperative	2.39	1.4	**<0.0001**
MHD postoperative	1.78	1.3	**0.01**
Mean Δ	0.60	0.125	**0.04**
P	**0.01**	0.28	
Pain			
Preoperative	2.3	1.98	0.17
Postoperative	1.04	0.83	0.34
Mean Δ	1.26	1.15	0.70
P	**0.001**	**<0.0001**	

Abbreviations: EQ-5D, EuroQol 5-dimension; MCS, Mental Composite Score; MHD, mental health domain; NDI, Neck Disability Index.
Boldface indicates statistically significant findings.

DISCUSSION

The purpose of this study was to compare postoperative outcomes following ACDF in patients with poor mental health across multiple PROMs, as well as to assess improvements in patient-reported depression/anxiety after surgery. Patients with poor mental health, as determined by a RAND-36 score of <60 in the mental health domains, demonstrated worse scores on both preoperative and postoperative assessment across all PROMs. However, despite lower outcome scores postoperatively compared to subjects without poor mental health, patients with poor mental health demonstrated significant improvement in PROM scores following ACDF. Additionally, patients with depressive symptoms reported improvement in these symptoms following ACDF. Our findings suggest that patients with lower mental health scores still improve following ACDF similarly to patients without depression, despite significantly lower preoperative PROMs. Additionally, there was no significant difference in the amount of change between preoperative and postoperative outcome scores between the 2 groups.

Several recent studies have examined the effect of mental health on outcomes following ACDF with a variety of measurement instruments, and there is a lack of consensus on the overall impact of this comorbidity. There also remains a lack of consensus regarding the impact of mental health on ACDF outcomes, and there are multiple studies arguing a negative effect as well as those that share conclusions similar to this study. In a large retrospective database study, Harris et al[4] found that a preoperative diagnosis of anxiety or depression led to an increased likelihood of adverse outcomes, opioid use, and increased healthcare costs following ACDF; however, this study did not include PROMs. Similarly, Alvi et al[5] found an increased risk of longer hospital stay or 30-day readmission following ACDF in patients with anxiety or depression. A study by Alvin et al[16] examined the effect of preoperative Patient Health Questionnaire-9, EQ-5D, and Pain Disability Questionnaire scores in patients undergoing ACDF and found that patients with a greater degree of depression experienced less improvement in quality of life than those with lesser degrees of depression. Additionally, Phan et al[17] found worse functional outcomes in depressed patients following ACDF using the Nurick score.

Conversely, Mangan et al[6] examined the impact of anxiety and depression on ACDF outcomes using preoperative and postoperative Physical Component Score, Mental Component Score, NDI, and visual analog scale and found that patients with mental health disorders had more severe symptoms preoperatively but no difference in postoperative outcome compared to those without anxiety or depression. Divi et al[7] utilized those same outcome measures as well as the Short Form-12 survey to determine the effect of preoperative mental health on ACDF outcomes and found that although patients with depression had worse PROMs before and after surgery they reported improvement similar to the group without depression. Jenkins et al[9] also found that patients with lower baseline mental health scores evaluated by the Patient Health Questionnaire-9 reported a similar degree of improvement to patients without mental health concerns. Goh et al[10] also examined the effect of preoperative mental health on ACDF outcomes utilizing the SF-36 mental component summary and found that patients with lower mental health scores preoperatively showed a similar degree of improvement compared to

those with higher preoperative scores. These studies support our findings that despite lower preoperative and postoperative PROM scores, patients with mental health concerns demonstrate significant improvement following ACDF.

We found that ACDF also yielded statistically significant improvements in self-reported depression and anxiety across the RAND and EQ-5D, with a majority of patients experiencing clinically significant improvements in these symptoms. Additionally, depressed/anxious patients experienced significantly greater improvements in their self-reported mental health across both the RAND and EQ-5D measures after surgery. Furthermore, the percentage of patients falling into the depressed category was significantly decreased after ACDF, from 32.4% to 19.9%. We were unable to show that patients with preoperative depression/anxiety had significantly worse pain intensity scores before or after surgery. While the size of our sample may have prevented detection of a statistically significant difference in pain between depressed and nondepressed groups, it is possible that pain response was not directly correlated with mental health status. It is known that ACDF classically produces a high rate of substantial pain relief, which can be irrespective of mental health status and is confirmed in this study.[6,7] Conversely, it may be that pain relief and the perception of a surgical success foster an environment for improved mental health, since the rate of depression in our cohort dropped by a third following surgery. Our results highlight the complexity of mental health status and the role it has in patient-reported outcomes after surgery.

We also were able to demonstrate for the first time that approximately 70% of depressed patients met the threshold for MCID in their self-reported mental health after surgery, suggesting that patient-reported depression and anxiety improve after ACDF, and that these improvements are actually clinically significant. Because this study is the first of its kind to assess changes in mental health status using multiple validated PROMs following primary ACDF, there are few data available with which to compare our findings. O'Neill et al[18] reported that ACDF yielded improvements in the Zung Depression Scale, but their study was assessing patients undergoing revision ACDF for adjacent segment disease and was conducted specifically to evaluate the cost utility of revision surgery, not mental health outcomes. Harris et al[4] found that patients with depression undergoing ACDF had higher postoperative opioid use, higher hospital resource utilization, and increased overall cost of health care. As suggested by Mangan et al,[6] reporting absolute improvements vs amount improved from baseline may lead to inconsistencies in interpretation.

Interestingly, we found that improvements in mental health were not directly related to pain intensity, and that depressed patients did not report higher pain intensity at either time point. As such, our findings of significant improvements in pain may be less related to actual pain intensity, but possibly the patients' perception of that pain, or catastrophic thinking regarding the uncertainty of undergoing spinal surgery. Coronado et al[19] found that pain catastrophizing decreased after ACDF, along with other measures of pain and disability, but this study was specifically looking at a telephone-based physical therapy protocol, not mental health outcomes. In a relatively exhaustive integrative systematic review, Strom et al[20] examined the influence of anxiety and depression in all spine surgery. They identified 5 categories of interdependent factors that had effects on anxiety and depression during the perioperative period: pain, information, disability, employment, and mental health.[20] Pain intensity was only associated with depression and anxiety, insofar as coping strategies would begin to fail as the pain became too intense; however, most of the included studies found a minimal association between pain and depression, besides "mental relief" as the pain decreased over time.[20] These results are similar to ours in this study, as we were unable to show a direct correlation between pain intensity and depression/anxiety. Furthermore, the authors found several studies in which patients with depression had higher rates of anxiety and posttraumatic stress disorder, were more prone to catastrophizing and had overall lower mental health scores.[20] These relationships were dampened by adequate information delivery, which allowed patients to cope "with the consequences of their condition," because they "knew what to expect."[20] With our findings, we hypothesize that once depressed or anxious patients are through the initial surgery, and as their symptoms improve, any presurgical anxiety and depression related to the prior symptoms may begin to decrease. This hypothesis, however, is untested and would require a more in-depth psychiatric assessment than can be broadly applied to utilize any standard surgical PROM. Additionally, as Strom et al[20] note in their systematic review, the validity of surgical PROMs is likely negatively influenced by inherent biases in patients self-reporting their function and disability, if those patients have active depression or anxiety.

This study has several limitations. The primary outcome measures in this study are PROMs, which are inherently subject to survey bias, and utilizing PROMs to establish symptomatic mental health issues is inherently different

than applying formal diagnostic criteria for anxiety and depression. Furthermore, it is unclear if any of these patients were receiving mental health treatment, which may affect the utility of our findings. Additionally, our cutoff for the RAND survey mental health composite was based on patients reporting depression or anxiety a majority of the time; however, this threshold has not previously been validated, and further research anchoring the RAND mental health composite to formal diagnoses of depression or anxiety would validate this threshold. Lastly, we included all patients undergoing ACDF regardless of diagnosis, and it is possible that the mental health of patients with myelopathy affects outcomes differently than for those with isolated radiculopathy. Despite these limitations, however, we were able to demonstrate that patients with self-reported depression or anxiety experience improvements after ACDF, consistent with previous reports in the literature.[7–10]

CONCLUSION

Overall, we found that depressed patients undergoing ACDF had a lower quality of life based on PROMs both preoperatively and postoperatively, but these patients still reported improvement after surgery. Furthermore, patients with self-reported depressive or anxious symptoms reported improvement in these symptoms following ACDF. Although patients with depression may have a worse clinical outcome than those without depression, this comorbidity should not be used to preclude a patient from receiving an indicated ACDF. Future research on the effects of behavioral health interventions on outcomes after surgery, particularly in patients with formal diagnoses of depression and anxiety, is ongoing.

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