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Does Neck Disability Index Correlate With 12-Month Satisfaction After Elective Surgery for Cervical Radiculopathy? Results From a National Spine Registry

BACKGROUND: Modern healthcare reforms focus on identifying and measuring the quality and value of care. Patient satisfaction is particularly important in the management of degenerative cervical radiculopathy (DCR) since it leads to significant neck pain and disability primarily affecting the patients' quality of life.

OBJECTIVE: To determine the association of baseline and 12-mo Neck Disability Index (NDI) with patient satisfaction after elective surgery for DCR.

METHODS: The Quality Outcomes Database cervical module was queried for patients who underwent elective surgery for DCR. A multivariable proportional odds regression model was fitted with 12-mo satisfaction as the outcome. The covariates for this model included patients' demographics, surgical characteristics, and baseline and 12-mo patient reported outcomes (PROs). Wald-statistics were calculated to determine the relative importance of each independent variable for 12-mo patient satisfaction.

RESULTS: The analysis included 2206 patients who underwent elective surgery for DCR. In multivariable analysis, after adjusting for baseline and surgery specific variables, the 12-mo NDI score showed the highest association with 12-mo satisfaction (Wald χ^2 -df = 99.17, 58.1% of total χ^2). The level of satisfaction increases with decrease in 12-mo NDI score regardless of the baseline NDI score.

CONCLUSION: Our study identifies 12-mo NDI score as a very influential driver of 12-mo patient satisfaction after surgery for DCR. In addition, there are lesser contributions from other 12-mo PROs, baseline Numeric Rating Scale for arm pain and American Society of Anesthesiologists (ASA) grade. The baseline level of disability was found to be irrelevant to patients. They seemed to only value their current level of disability, compared to baseline, in rating satisfaction with surgical outcome.

KEY WORDS: Cervical spine, Degenerative cervical radiculopathy, Neck Disability Index, Satisfaction, Adult spine surgery

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Modern healthcare reforms focus on identifying and measuring the quality and value of care.^{1,2} Within many

ABBREVIATIONS: ASA, American Society of Anesthesiologists; BMI, body mass index; CAD, coronary artery disease; DCR, degenerative cervical radiculopathy; EQ-5D, EuroQol 5 dimensions; NDI, Neck Disability Index; NASS, North American Spine Satisfaction; NRS-AP, Numeric Rating Scale for arm pain; NRS-NP, Numeric Rating Scale for neck pain; PROs, patient reported outcomes; QOD, Quality Outcomes Database

fields of medicine, and certainly for spine surgery, patient satisfaction has become a central part of this effort.³ The North American Spine Satisfaction (NASS) questionnaire, along with other available instruments, is therefore being utilized in many prospective registries to measure outcomes after surgery.^{4–6} Of note, post-treatment satisfaction is known to depend on many factors related to physician-patient interaction, including some which are not directly related to the quality of care.^{7–10} Therefore the literature suggests that patient satisfaction should

not be utilized as a solitary metric for measuring quality and outcomes.^{11,12}

An important component of health-care quality assessment is patient satisfaction. A patient's satisfaction with care is distinct measure and is analyzed separate from patient's satisfaction with outcomes after a surgical procedure. NASS questionnaire is developed and has been widely used to assess a patient's satisfaction with outcomes after spine surgery.⁴ Patient satisfaction is particularly important in the management of degenerative cervical radiculopathy (DCR). A compression or irritation of the cervical nerve root or its branches away from the spinal cord leads to significant pain with associated weakness and numbness that radiates to shoulder travelling down the arm and hand. The resultant disability primarily affects the patients' quality of life. DCR has a reported annual incidence and prevalence of 83.2/100 000 persons and 3.5/1000 persons respectively.¹³⁻¹⁵ The Neck Disability Index (NDI) remains the most reliable and validated metric for disability in patients with neck pain.¹⁶⁻¹⁸ The NDI score takes into account neck-related physical and mental factors which impact one's ability to function in daily life.^{19,20}

In this study, we set out to determine the correlation of baseline and 12-mo NDI with patient satisfaction after elective surgery for DCR. We hypothesized that a decreased baseline NDI and 12-mo NDI would be associated with increased satisfaction after surgery.

METHODS

The Quality Outcomes Database (QOD), a nationwide web-based prospective longitudinal registry for surgical spine care, was utilized for this study. The 62 participating sites have over 5000 patients with 12-mo follow-up who underwent cervical surgery. Within sites, patients are enrolled either continuously or on a prespecified rotating cycle ensuring unbiased enrolment into the registry.²¹ This includes patients with diagnoses of stenosis, symptomatic instability, disc herniation, and adjacent segment disease. Patients with spinal infection, tumor, traumatic fracture or dislocation, neurologic paralysis with pre-existing spine pathology, incarceration or age less than 18 yr are not included. The QOD cervical module was queried for patients who underwent elective surgery for DCR.

At the time of enrollment into the registry, patient demographics, disease-specific and surgical variables were recorded. The following variables were collected via the electronic medical record review: age, gender, body mass index (BMI), ASA grade, history of diabetes, coronary artery disease (CAD), osteoporosis, symptom duration (< or > 3 mo), preoperative ambulatory status, diagnosis, and surgery-specific variables. Patient interviews were used to collect the following patient-reported variables: race, smoking status, anxiety, depression, education (less than high school, high school, 2-yr college, 4-yr college, postcollege), employment status, type of occupation (sedentary, light manual labor, medium labor, heavy labor), workers' compensation, and liability insurance.

Patients also completed surveys at baseline and 12-mo via phone interview or self-administration. The surveys were comprised of validated questionnaires to assess patient reported outcomes (PROs) of EuroQol 5 dimensions (EQ-5D),^{22,23} NDI, and Numeric Rating Scale for neck pain

(NRS-NP) and arm pain (NRS-AP). NDI scores can be categorized as no disability (0%-8%), mild disability (10%-28%), moderate disability (30%-48%), severe disability (50%-68%), and complete disability (70%-100%).²⁴ NASS satisfaction questionnaire was administered at 12-mo postoperative to assess treatment satisfaction.⁴ The satisfaction index is measured at 4 point categories; 1) 'Surgery met my expectations', 2) 'I did not improve as much as I had hoped but I would undergo the same operation for the same results', 3) 'Surgery helped but I would not undergo the same operation for the same results', or 4) 'I am the same or worse as compared to before surgery'. The categories are ordinal with '1' as the most satisfied to '4' as least satisfied/dissatisfied. REDCap web-based secure data management platform was used for collection of these aggregate data.²⁵

Statistical Analysis

Frequency and proportions for categorical variables, and median and quartiles for continuous variables were calculated. A multivariable proportional odds regression model was fitted with 12-mo satisfaction as the outcome. The covariates for this model included age, gender, BMI, race, education level, occupation, history of prior surgery, smoking status, diabetes mellitus, CAD, osteoporosis, anxiety, depression, ASA grade, symptom duration, indication for surgery, workers' compensation, liability claim, anterior vs posterior approach, the need for fusion, and baseline and 12-mo PROs. Wald statistics were calculated to determine the relative importance of the predictors for 12-mo patient satisfaction. All analyses were conducted using R 3.1.2 (R Foundation for Statistical Computing, Vienna, Austria) and the rms (Regression Modeling Strategies) package 16, with a significance value of 0.05.^{26,27}

IRB Approval/Research Ethics Committee

The QOD project is designated as a nonresearch, clinical quality improvement effort and based on existing federal guidelines exempted from IRB review.

RESULTS

The QOD cervical module has a total of 3502 patients who underwent surgery for DCR who were eligible for 12-mo follow-up. With the 12-mo follow-up rate of 63%, 2206 patients had complete preoperative and 12-mo follow-up and were included in the present analysis. Table 1 summarizes the cohort characteristics in addition to surgical details. Table 2 summarizes baseline and 12-mo PROs, with significant improvement noted for all PROs post-treatment. Out of 2206 patients, 1481 (67%) of the patients reported satisfaction at NASS level 1 (Surgery met my expectations) and 449 (20%) reported satisfaction at NASS level 2 (I did not improve as much as I had hoped but I would undergo the same operation for the same results), while a total of 278 (13%) reported lower level of satisfaction or dissatisfaction at 12-mo follow-up.

In multivariable analysis, after adjusting for baseline and surgery specific variables, the 12-mo NDI score showed the highest association with 12-mo satisfaction (Wald χ^2 -df = 99.17, 58.1% of the total χ^2 ; Figure 1). Figure 2 summarizes the relationship between satisfaction level, baseline NDI, and 12-mo NDI score using a heat map. The white color represents

TABLE 1. Characteristics of the Study Cohort (n = 2206)

Variable	n (%)
Male gender	1112 (50)
Age (years) Median (Q1, Q3)	53 (46, 61)
Race	
White	1970 (89)
Black	179 (8)
Other	57 (3)
Education	
Less than high school	103 (5)
High school or GED	933 (43)
2-yr college	408 (19)
4-yr college	440 (20)
Postgraduate	284 (13)
Worker's compensation	104 (5)
Liability claim	134 (6)
Diabetes mellitus	302 (14)
CAD	141 (7)
Osteoporosis	71 (3)
Anxiety	437 (23)
Depression	490 (26)
Current smoker	478 (22)
BMI Median (Q1, Q3)	28.9 (25.6, 33.3)
Symptom duration	
< 3 mo	402 (19)
3–12 mo	868 (40)
> 12 mo	876 (41)
ASA grade	
1	187 (8)
2	1412 (64)
3	607 (28)
Surgical approach	
Posterior only	378 (17)
Anterior only	1828 (83)
Type of occupation	
Sedentary	428 (19)
Light	296 (13)
Medium	334 (15)
Heavy	280 (13)
Disabled	236 (11)
Retired	396 (18)
Other	230 (10)

higher level of satisfaction (ie, level 1 on the NASS satisfaction index), whereas black represents lowest satisfaction (ie, level 4 on the NASS satisfaction index). The level of satisfaction increases with decrease in 12-mo NDI score regardless of the baseline NDI score. The heat map reveals that a higher baseline NDI demands a significant decrease in NDI score at 12-mo in order to achieve satisfaction. The regression model identified other factors which significantly associated with 12-mo satisfaction, including NRS-AP at 12-mo, EQ-5D 12-mo, baseline NDI, NRS-NP at 12-mo, baseline NRS-AP, and ASA grade in descending order of their correlation (Figure 1).

TABLE 2. Patient-Reported Outcomes Baseline and 12-mo After Surgery (n = 2206)

	Baseline	12-mo	P value*
NDI score	30.0, 42.0, 54.0 (42.5 ± 17.7)	2.0, 12.0, 30.0 (18.9 ± 19.2)	<.001
EQ-5D score	0.416, 0.689, 0.778 (0.601 ± 0.219)	0.708, 0.816, 1.000 (0.789 ± 0.210)	<.001
NRS-NP	5.00, 7.00, 8.00 (6.20 ± 2.76)	0.00, 2.00, 4.00 (2.53 ± 2.75)	<.001
NRS-AP	4.00, 7.00, 8.00 (6.00 ± 2.93)	0.00, 0.00, 3.00 (1.94 ± 2.74)	<.001
Satisfaction**			
1	-	1481 (67)	
2	-	449 (20)	
3	-	108 (5)	
4	-	165 (8)	

a, b, c lower quartile a, the median b, upper quartile c (mean ± SD)

*Wilcoxon signed rank test

**N (%)

NASS Satisfaction:

1 = Surgery met my expectations

2 = I did not improve as much as I had hoped but I would undergo the same operation for the same results.

3 = Surgery helped but I would not undergo the same operation for the same results.

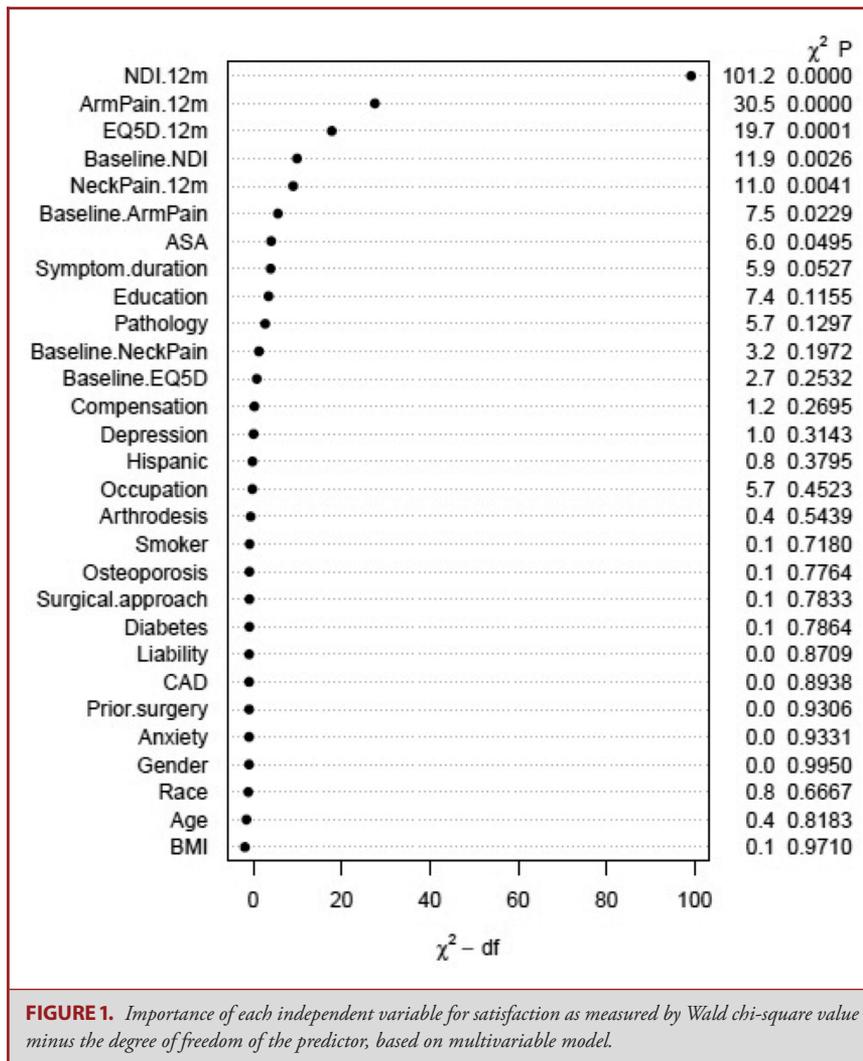
4 = I am the same or worse as compared to before surgery.

DISCUSSION

Key Results and Interpretation

DCR is a debilitating condition with significant impairment and exacts a significant toll on patients' economic productivity, social functioning, and psychological health. The goal in treating these patients is an expedited return to normal health-related quality of life. Some improve with conservative therapy²⁸⁻³⁰; whereas up to 25% of patients have persistent symptoms and are candidates for surgical management.^{31,32} On average, patients who undergo surgical treatment show significant improvement in pain, neurologic deficits, and functions of daily living as compared to medical management, although surgical candidates tend to have higher disability and neurologic symptoms pretreatment.³³ Although patients' functionality improves significantly following spine surgery, the specific association of baseline and 12-mo NDI with satisfaction has not been examined systematically with data from a national database.

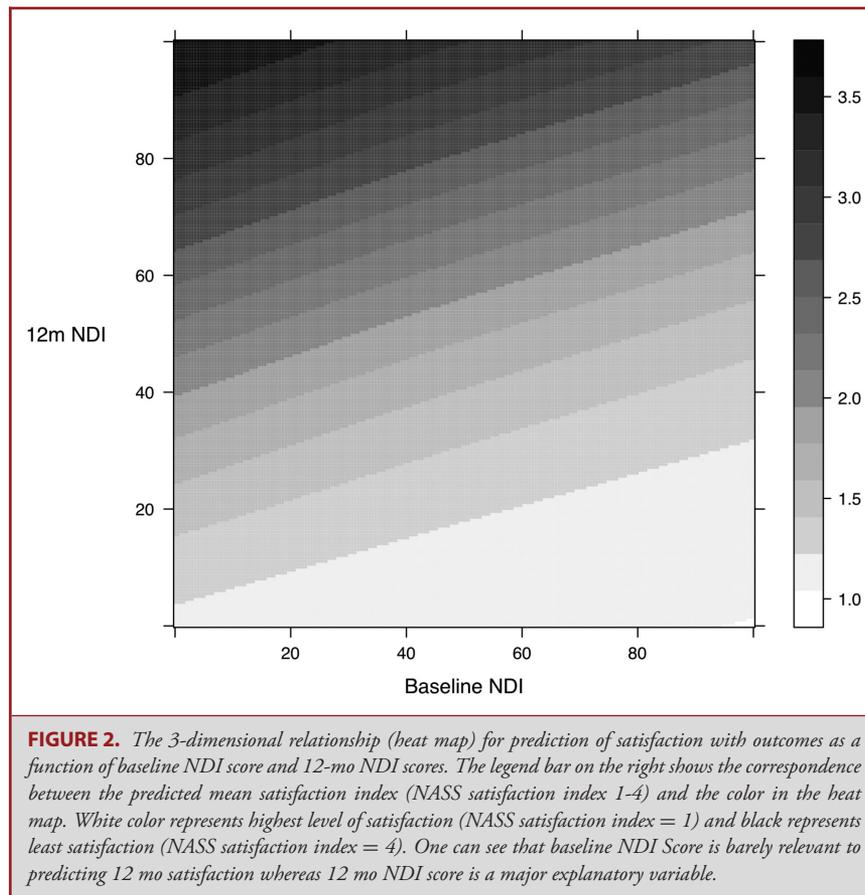
Our analysis demonstrates that the 12-mo postoperative NDI score has the highest association with patient satisfaction when adjusted for other patient and surgical characteristics. It also shows that patients with higher baseline NDI scores require greater improvement in NDI to achieve satisfaction. This can be understood through a hypothetical scenario in which one patient has high baseline NDI (higher disability) and another has low baseline NDI (lower disability). If both patients achieve identical NDI scores at 12 mo, their odds of achieving satisfaction will also



be similar. The magnitude of improvement in NDI after surgery is less important for satisfaction than the final NDI scores itself. This has significant implications when assessing the success of surgeries for DCR, because a surgeon whose operation takes a patient from an NDI of 80 to 60 could foreseeably be penalized for not achieving satisfaction, while a surgeon who takes a patient from an NDI of 45 to 40 could be rewarded for achieving satisfaction.

We also found that, in addition to the 12-mo NDI score, satisfaction is influenced by NRS-AP at 12-mo, EQ-5D 12-mo, baseline NDI score, NRS-NP at 12-mo, baseline NRS-AP, and ASA grade in descending order of their importance. These findings are consistent with previously reported predictors of satisfaction for patients that are surgically managed for degenerative spine disease.^{7,34} Previously, literature has shown pain relief after surgery correlating well with treatment satisfaction.³⁵⁻³⁷

Mannion et al³⁸ reported that an important factor for satisfaction is fulfillment of patients' expectations. In our analysis, we did not measure patients' expectations objectively; however, Mancusos et al³⁹ found that reduced postoperative pain and disability were correlated well with expectations being met. Likewise, Soroceanu et al⁴⁰ reported that patients with realistic expectations regarding pain and functionality improvement attained a higher level of satisfaction with the delivered treatment. Of the 10 component questions that make up NDI, 7 are related to activities of daily life, 2 are related to pain, and 1 is related to concentration.⁴¹ Patient satisfaction is quite subjective, with contributions from patients' socioeconomic status, lifestyle, expectations, mental and physical health. The component-questions of NDI take into account many of these elements, which may explain why it has a larger correlation with long-term satisfaction than objective measures of pain (NRS-NP/AP).



Limitations and Generalizability

The results of this study must be interpreted while acknowledging the inherent limitations of retrospective analyses of prospectively collected data. Another limitation is the issue of drop out in real world registries, and the present population had a follow-up completion rate of around 63%; however, the total number of enrolled patients compensates for the follow-up rate. Nonetheless, utilizing robustly collected prospective data from across the United States, we believe that our results are generalizable to a reasonable degree. Our results show that the 12-mo NDI score has the highest association with satisfaction; however, the influence of other factors found significant in our analysis must not be undervalued when explaining variation in patient satisfaction.

CONCLUSION

Our study identifies 12-mo NDI score as an influential driver of 12-mo patient satisfaction after surgery for DCR. In addition, there are lesser contributions from other 12-mo PROs, baseline NRS-AP, and ASA grade. We also demonstrate that higher baseline disability requires greater improvement

postsurgery in order to achieve patient satisfaction. Baseline NDI should therefore be accounted for, in addition to patient satisfaction, when assessing the success of surgery for DCR.

Disclosures

Dr Archer reports personal fees from Pacira, and personal fees from the American Physical Therapy Board, outside the submitted work. Dr Mummaneni reports a consultant relationship with DePuy Spine and Stryker Spine; direct stock ownership in Spinicity ISD; receipt of royalties from DePuy Spine, Thieme Publishing, and Springer Publishing; receipt of honoraria from Globus and AOSpine; grant receipt from AOSpine and receipt of support for clinical or research efforts from ISSG, outside the submitted work. Dr Foley reports personal fees from Medtronic, Nuvasive, and SpineWave, outside the submitted work. Dr Asher reports consulting for Hyperbranch Medical Technologies. Dr Devin reports a Stryker grant, Stryker consulting, Wright medical, Defense expert witness, and Medtronic legal consulting outside the submitted work. The other authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper. The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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