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Impact of Dominant Symptom on 12-Month Patient-Reported Outcomes for Patients Undergoing Lumbar Spine Surgery

BACKGROUND: The impact of symptom characteristics on outcomes of spine surgery remains elusive.

OBJECTIVE: To determine the impact of symptom location, severity, and duration on outcomes following lumbar spine surgery.

METHODS: We queried the Quality Outcomes Database (QOD) for patients undergoing elective lumbar spine surgery for lumbar degenerative spine disease. Multivariable regression was utilized to determine the impact of preoperative symptom characteristics (location, severity, and duration) on improvement in disability, quality of life, return to work, and patient satisfaction at 1 yr. Relative predictor importance was determined using an importance metric defined as Wald χ^2 penalized by degrees of freedom.

RESULTS: A total of 22 022 subjects were analyzed. On adjusted analysis, we found patients with predominant leg pain were more likely to be satisfied ($P < .0001$), achieve minimum clinically important difference (MCID) in Oswestry Disability Index (ODI) ($P = .002$), and return to work ($P = .03$) at 1 yr following surgery without significant difference in Euro-QoL-5D (EQ-5D) ($P = .09$) [ref = predominant back pain]. Patients with equal leg and back pain were more likely to be satisfied ($P < .0001$), but showed no significant difference in achieving MCID ($P = .22$) or return to work ($P = .07$). Baseline numeric rating scale-leg pain and symptom duration were most important predictors of achieving MCID and change in EQ-5D. Predominant symptom was not found to be an important determinant of return to work. Worker's compensation was found to be most important determinant of satisfaction and return to work.

CONCLUSION: Predominant symptom location is a significant determinant of functional outcomes following spine surgery. However, pain severity and duration have higher predictive importance. Return to work is more dependent on sociodemographic features as compared to symptom characteristics.

KEY WORDS: Dominant symptom, Leg pain, Back pain, Lumbar, Spine surgery, Patient-reported outcomes, Registry, Spondylolisthesis, Lumbar spine, Outcomes, Quality Outcomes Database, QOD

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Low back pain because of degenerative spine disease is an extremely common pathology with an estimated lifetime prevalence of 60% to 90%.[1] It is the second most common reason for seeking medical attention and the most common reason for disability and loss of work hours in the United States.[2-4] Moreover, patients with back pain undergoing a spinal surgery are more likely to be impacted negatively by their disease, compared to other pathologies.[5]

ABBREVIATIONS: ANR, arm pain to neck pain ratio; **ASA,** American Society of Anesthesiologists; **BMI,** body mass index; **CAD,** coronary artery disease; **EQ-5D,** Euro-QoL-5D; **IQR,** interquartile range; **IRB,** Institutional Review Board; **MCID,** minimum clinically important difference; **NASS,** North American Spine Society; **NRS-BP,** Numeric rating scale-back pain; **NRS-LP,** Numeric rating scale-leg pain; **ODI,** Oswestry Disability Index; **PCS,** Physical Component Score; **PRO,** patient-reported outcome; **QOD,** Quality Outcomes Database; **SF-36,** 36-Item Short-Form Health Survey

The incidence of surgery for low back pain has increased exponentially over the past 2 decades, with some studies suggesting a 300% increase in lumbar fusions.[6-9] However, the efficacy of surgery varies greatly among patients. Thus, providers and third party payers are keenly interested in identifying key factors that impact outcomes of such patients.[10,11]

The presenting symptoms of degenerative spine disease vary from low back pain alone to back pain with leg pain, with some reporting one pain to be more severe than the other. Other symptoms may include radiculopathic signs, such as numbness and tingling, as well as myelopathic signs such as lower limb weakness.[12] Although several studies have investigated the association of patient-related and clinical factors on outcomes of surgery, the impact of the type of pain presentation and symptom on outcomes of spine surgery remains elusive.[10,13] The severity and duration of symptoms is also a critical determinant for decision making to operate among such patients. Herein, we present an analysis of the impact of the predominant pain symptom severity and duration at presentation on postoperative outcomes of patients undergoing surgery for lumbar degenerative disease from a prospective national registry.

METHODS

Data Source and Patient Cohort

The Quality Outcomes Database (QOD) registry was queried for patients who underwent a lumbar spine surgery and had baseline information available for the presenting symptom type and completed 1-yr follow-up. The QOD is the largest national prospective registry and has been enrolling patients since 2012. Its overarching objective is to evaluate risk-adjusted expected morbidity and 12-mo outcomes with the aim of improving efficiency and quality of care for patients undergoing commonly performed surgical spine procedures.[14,15] More information on the lumbar spine module can be found on the website (http://www.neuropoint.org/registries/qod-spine/#1519913148052-7431e7be-7f5f). The general inclusion and exclusion criteria for the QOD spine modules have been described elsewhere.[10,14,15] Because data in QOD are de-identified, Institutional Review Board (IRB) approval was neither sought nor required.

Demographic Variables

The following variables were recorded from electronic medical records[10]: age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, history of coronary artery disease (CAD), diabetes, depression, anxiety, symptom duration, preoperative motor deficit, diagnosis, ambulatory status, and surgery-specific variables including approach (posterior, anterior, and lateral only), number of operative levels, and need for arthrodesis. Other variables recorded from patient interviews and then confirmed from electronic medical records include race, ethnicity, smoking status, education, employment, occupation, and insurance status (private, uninsured, Medicare, Medicaid, and worker's compensation).

Interviews and PRO Questionnaires

The self-reported predominant symptom at presentation comprised the primary predictor of interest. This is classified in the QOD lumbar module as leg pain greater than back pain, back pain greater than leg pain, and leg pain equal to back pain. Baseline (preoperative), 3-mo, and 1-yr postoperative disability (Oswestry Disability Index [ODI])[16], quality of life (Euro-QOL 5D: EQ-5D),[17] patient satisfaction (North American Spine Society [NASS] satisfaction questionnaire),[18] numeric rating scales for leg pain (NRS-LP) or back pain (NRS-BP) severity, and return to work were assessed either through telephone interviews conducted by a data coordinator at each site or self-administration during clinic visit or by mail. The NASS satisfaction scale is 1 item with the 4 following responses: (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," and (4) "I am the same or worse as compared to before surgery." This was classified as an ordinal variable for analysis. All the outcomes of interest were collected in clinic at follow-up visits or via telephone.

Outcomes of Interest

The following 1-yr patient-reported outcomes (PROs) were included as outcomes of interest: quality of life (assessed using EQ-5D), patient satisfaction following surgery (assessed using the NASS satisfaction) as an ordinal variable, disability (assessed using ODI), and return to work. The disability outcome for analysis was defined as achieving or not achieving a minimally clinically important difference (MCID) at 1 yr of 12.8 points on the ODI.[19]

Statistical Analysis

Medians with quartiles for continuous variables and frequency with proportions for categorical variables were calculated for patient demographics and other covariates (see Interviews and PRO Questionnaires). A multivariable linear regression model was fitted for change in EQ-5D. Multivariable binomial logistic regression models were fitted for achieving MCID in ODI and return to work at 1 yr, whereas satisfaction was assessed using a multivariable proportional odds regression model with the predominant symptom as the primary predictor after adjusting for a priori demographic, operative, and treatment factors. Baseline back pain and leg pain scores (NRS-BP and NRS-LP) were also included in the models. Multiple imputation was performed to account for missing data. In the preliminary analyses, interaction terms between the duration, severity, and dominant location of symptoms were used; however, it was not significant. Relative predictor importance was assessed using a metric defined as Wald χ^2 penalized by the predictor degrees of freedom with a higher metric indicating higher importance of the variable. All P values were 2-sided with level of significance at $<.05$. All statistical analyses were performed using "R" Statistical software version 3.4.1 (R: A language and environment for statistical computing; R Foundation for Statistical Computing, Vienna, Austria; https://www.R-project.org/) and "rms" package, whereas multiple imputation was performed using "Hmisc" package.[20]

RESULTS

Baseline Characteristics

A total of 22 022 subjects met inclusion criteria. Of these, 23% (n = 5055) were found to have back greater than leg pain, 34.6% (N = 7627) were found to have leg greater than back pain, whereas 42.4% (n = 9340) were found to have equal back and leg pain at presentation (Table 1). The median age of the cohort was 62 yr (interquartile range [IQR]: 51-70), and 47% (n = 10 381)

TABLE 1. Baseline Demographic, Clinical, Operative Characteristics and Patient Reported Outcomes of the Cohort (n = 22 022)

Demographics	
Age (yr), median (IQR)	62 (51-70)
Females, n (%)	10 381 (47.1)
Race, n (%)	
Caucasian	19 699 (89.5)
African-American	1514 (6.8)
Other	809 (3.7)
Ethnicity, n (%)	
Hispanic	539 (2.4)
Non-Hispanic	21 171 (96.1)
Unknown	312 (1.4)
Insurance status, n (%)	
Medicare	8561 (38.9)
Medicaid	1015 (4.6)
Uninsured	191 (0.8)
Private insurance	11 522 (52.3)
Unknown	43 (0.2)
Worker's compensation, n (%)	825 (3.7)
Education, n (%)	
Less than high school	1166 (5.3)
High school	9388 (42.6)
Two-year college	3886 (17.6)
Four-year college	4012 (18.2)
Postcollege	3003 (13.6)
Unknown	567 (2.6)
Employment status, n (%)	
Currently working	7984 (36.3)
On leave/short-term disability	2037 (9.2)
Unemployed	11 857 (53.8)
Attending school	120 (0.5)
Unknown	24 (0.1)
Employment type, n (%)	
Sedentary	3156 (14.3)
Light	2361 (10.7)
Medium	2451 (11.1)
Heavy	1996 (9.1)
Unknown	12 058 (54.8)
Clinical characteristics	
Predominant symptom, n (%)	
Pain	17 162 (78)
Weakness	926 (4.2)
Numbness/tingling	2730 (21.4)
Predominant pain location, n (%)	
Back pain	5055 (23)
Leg pain	7627 (34.6)
Back pain and leg pain	9340 (42.4)
Symptom duration, n (%)	
Less than 3 mo	2466 (1.1)
Greater than 3 mo	19 211 (87.2)
Unknown	345 (1.6)
Preop ambulation, n (%)	
Independent	18 501 (84)
With assist device	3027 (13.7)
Unknown	494 (2.2)
Motor deficit, n (%)	5998 (27.2)
BMI (kg/m^2), median (IQR)	29.5 (26.0-33.8)
Smoking	
Yes	18 400 (83.5)
No	3617 (16.5)
Depression, n (%)	4479 (20.3)
Anxiety, n (%)	3643 (16.5)
Diabetes, n (%)	4114 (18.7)
CAD, n (%)	2572 (11.7)
Operative characteristics	
ASA grade, n (%)	
≤2	13 035 (59.1)
>2	8864 (40.2)
Unknown	123 (0.6)
Fusion, n (%)	8017 (36.4)
Surgical approach, n (%)	
Posterior only	20 818 (94.5)
Anterior only	333 (1.5)
Lateral only	296 (1.3)
Two-stage	561 (2.5)
Unknown	149 (0.06)
Maximum levels involved, median (IQR)	2.0 (1.0-2.0)
Baseline patient-reported outcomes	
NRS-BP, median (IQR)	7 (5-9)
NRS-LP, median (IQR)	8(6–9)
ODI, median (IQR)	46.7 (35.0-57.8)
EQ-5D, median (IQR)	0.60 (0.36-0.75)

ASA: American Society of Anesthesiologists; BMI: body mass index; CAD: coronary artery disease; EQ-5D: Euroqol-5D; IQR: interquartile range; NRS-BP: Numeric Rating Scale-Back Pain; NRS-LP: Numeric Rating Scale-Leg Pain; ODI: Oswestry Disability Index.

were females. Most subjects were white (89.5%, n = 19 699) and nonsmokers (83.5%, n = 18 400). About 36.3% (n = 7984) of patients were employed at the time of surgery, and 14.3% of these patients (N = 3156) had a sedentary job. A majority of patients had symptom duration of greater than 3 mo (87.2%, n = 19 211) and had an ASA grade of 1 or 2 (59%, n = 13 035). Fusion was performed in 36.4% (n = 8017) patients.

Change in 12-Month EQ-5D

The median change in EQ-5D was 0.22 (IQR: 0.05-0.40). Multivariable linear regression fitted for change in EQ-5D found that leg pain compared to back pain predominance was not associated with significant change in EQ-5D (β = 0.009, 95% CI = –0.001 to 0.02, P = .09). However, equal leg and back pain compared to back pain predominance (β = –0.01, 95% CI = –0.02 to –0.004, P = .002) was negatively associated with change in EQ5D. Higher baseline NRS-BP (β = 0.007, 95% CI = 0.006-0.008, P < .001), higher baseline NRS-LP (β = 0.020, 95% CI = 0.019-0.022, P < .001), and symptom duration < 3 mo (β = 0.08, 95% CI = 0.06-0.08, P < .001) were also significantly associated with higher improvement in EQ-5D (Table 2).

TABLE 2. Multivariable Linear Regression to Assess Impact of Dominant Symptom on Change in EQ-5D at 12 Months

Variable	β^* (95% CI)	*P* value
Age	−0.001 (−0.001 to −0.0009)	**.002**
Sex		
Female	0.005 (−0.001 to 0.02)	.16
Male	Reference	Reference
Race		
Caucasian	Reference	Reference
African-American	−0.04 (−0.05 to −0.03)	**<.0001**
Other	−0.003 (−0.02 to 0.01)	.72
Ethnicity		
Hispanic	0.006 (−0.02 to 0.03)	.58
Non-Hispanic	Reference	Reference
Education		
Postcollege	0.05 (0.04 to 0.07)	**<.0001**
Four-year college	0.05 (0.03 to 0.06)	**<.0001**
Two-year college	0.04 (0.03 to 0.06)	**<.0001**
High school	0.03 (0.01 to 0.04)	**.0002**
Less than high school	Reference	Reference
Insurance		
Medicare	0.006 (−0.03 to 0.04)	.72
Medicaid	−0.04 (−0.08 to −0.004)	**.03**
VA/Govt.	−0.02 (−0.05 to 0.02)	.4
Private	0.009 (−0.02 to 0.04)	.6
Uninsured	Reference	Reference
Worker's compensation		
Yes	−0.05 (−0.07 to −0.04)	**<.0001**
No	Reference	Reference
Predominant pain location		
Back pain	Reference	Reference
Leg pain	0.009 (−0.001 to 0.02)	.09
Equal back and leg pain	−0.01 (−0.02 to −0.004)	**.003**
Symptom duration		
<3 mo	0.08 (0.06 to 0.08)	**<.0001**
>3 mo	Reference	Reference
Baseline NRS-BP	0.08 (0.001 to 0.009)	**<.0001**
Baseline NRS-LP	0.02 (0.01 to 0.02)	**<.0001**
Preop ambulation		
Independent	Reference	Reference
With assist device	0.04 (0.03 to 0.05)	**<.0001**
Motor deficit	0.001 (−0.01 to 0.008)	.9
BMI	−0.001 (−0.002 to −0.0004)	**.01**
Current smoker	−0.02 (−0.03 to −0.01)	**<.0001**
Depression	0.0001 (−0.01 to 0.01)	1.0
Anxiety	−0.01 (−0.02 to −0.001)	.03
Diabetes	−0.004 (−0.01 to 0.0004)	.3
CAD	0.002 (−0.008 to 0.01)	.7
ASA grade		
≤2	Reference	Reference
>2	−0.03 (−0.03 to −0.02)	**<.0001**
Fusion	−0.006 (−0.01 to 0.001)	.10
Surgical approach		
Posterior only	Reference	Reference
Anterior only	0.01 (−0.01 to 0.04)	.4
Lateral only	0.05 (0.02 to 0.08)	**.0001**
Two-stage	0.004 (−0.02 to 0.02)	.64
No. of levels	−0.001 (−0.005 to 0.003)	.7

Bold values indicates statistical significance at $P \leq .05$.

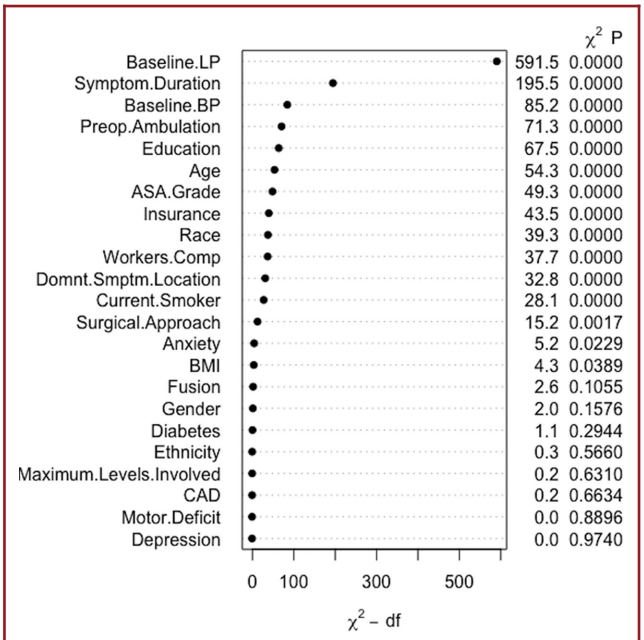

FIGURE 1. *Relative predictive importance analysis for the multivariable linear regression model for change in EQ-5D.*

Relative predictor importance analysis revealed that baseline NRS-LP (Wald χ^2 591.5, accounting for 44% of total χ^2) and symptom duration (Wald χ^2 195.5, accounting for 14% of total χ^2) were the strongest predictors of change in EQ-5D. Dominant symptom location was not an important predictor of change in EQ-5D (Wald χ^2 32.8, accounting for 2.4% of total χ^2) (Figure 1).

Achieving MCID for 12-Month ODI

Overall, nearly 70% (n = 15 310) of patients achieved MCID in ODI at 1 yr. Multivariable binomial logistic regression revealed that higher NRS-LP (OR = 1.11, 95% CI = 1.1-1.12, $P < .001$) and predominant leg pain compared to predominant back pain (OR = 1.17, 95% CI = 1.06-1.30, $P = .002$) were factors significantly associated with higher odds of achieving MCID. Equal back and leg pain compared to predominant back pain (OR = 1.05, 95% CI = 0.96-1.14, $P = .22$) and baseline NRS-BP (OR = 1.02, 95% CI = 0.99-1.03, $P = .053$) were not significantly associated with odds of achieving MCID (Table 3).

Baseline NRS-LP (Wald $\chi^2 = 175.5$, accounting for 24% of total χ^2) and symptom duration (Wald $\chi^2 = 108$, accounting for 14.7% of total χ^2) were most important predictors of achieving MCID. Predominant symptom was a statistically significant but relatively less important predictor of achieving MCID (Wald $\chi^2 = 10.9$, accounting for 1.6% of total χ^2) (Figure 2).

TABLE 3. Multivariable Logistic Regression to Assess Impact of Dominant Symptom on Odds of Achieving MCID

Variable	OR* (95% CI)	*P* value
Age	0.99 (0.98-0.99)	**<.0001**
Sex		
Female	1.12 (1.05-1.19)	**.0004**
Male	Reference	Reference
Race		
Caucasian	Reference	Reference
African-American	0.64 (0.57-c0.72)	**<.0001**
Other	1.05 (0.88-1.25)	.6
Ethnicity		
Hispanic	0.84 (0.68-1.03)	.09
Non-Hispanic	Reference	Reference
Education		
Postcollege	1.35 (1.16-1.57)	**.0001**
Four-year college	1.38 (1.19-1.60)	**<.0001**
Two-year college	1.35 (1.17-1.56)	**<.0001**
High school	1.11 (0.97-1.27)	.11
Less than high school	Reference	
Insurance		
Medicare	1.09 (0.79-1.51)	.60
Medicaid	0.68 (0.48-0.95)	**.02**
VA/Govt.	0.85 (0.60-1.21)	.37
Private	1.14 (0.83-1.57)	.41
Uninsured	Reference	Reference
Worker's compensation		
Yes	0.57 (0.49-0.67)	**<.0001**
No	Reference	Reference
Predominant pain location		
Back pain	Reference	
Leg pain	1.17 (1.06-1.30)	**.002**
Equal back and leg pain	1.05 (0.97-1.14)	.22
Symptom duration		
<3 mo	1.80 (1.61-2.10)	**<.0001**
>3 mo	Reference	
Baseline NRS-BP	1.02 (1.00-1.03)	.053
Baseline NRS-LP	1.11 (1.09-1.12)	**<.0001**
Preop ambulation		
Independent	Reference	
With assist device	1.15 (1.04-1.26)	**.004**
Motor deficit	0.96 (0.89-1.02)	.20
BMI	0.99 (0.98-1.00)	**.03**
Current smoker	0.75 (0.69-0.82)	**<.0001**
Depression	0.91 (0.84-0.99)	**.04**
Anxiety	0.83 (0.76-0.91)	**<.0001**
Diabetes	0.94 (0.87-1.02)	.1
CAD	0.96 (0.87-1.02)	.4
ASA grade		
≤2	Reference	
>2	0.78 (0.73-0.85)	**<.0001**
Fusion	1.04 (0.97-1.11)	.2
Surgical approach		
Posterior only	Reference	
Anterior only	0.79 (0.63-1.01)	.06
Lateral only	1.12 (0.86-1.46)	.40
Two-stage	0.84 (0.70-1.01)	.06
No. of levels	0.92 (0.89-0.96)	**<.0001**

*Odds Ratios for continuous variables (age, BMI, baseline NRS-BP, NRS-LP, no. of levels) are expressed as interquartile range odds ratios.
Bold values indicates statistical significance at $P \leq .05$.

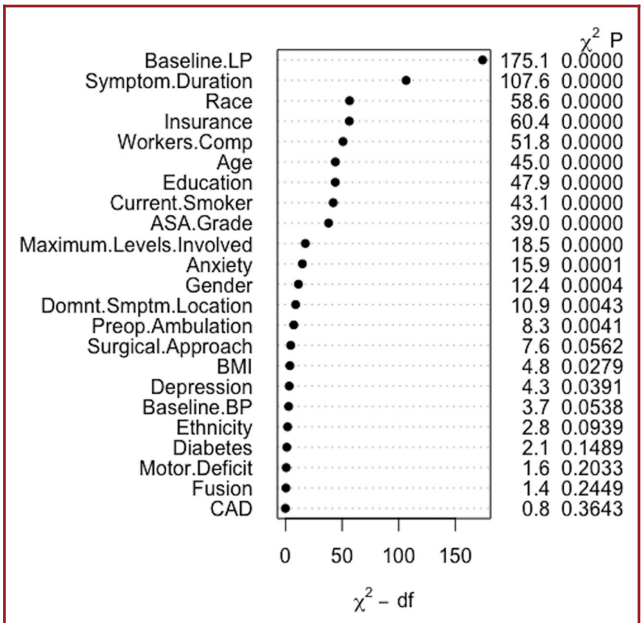

FIGURE 2. *Relative predictive importance analysis for the multivariable logistic regression model for achieving MCID in ODI at 12 mo.*

Return to Work at 1 Year

Of the 9971 patients who were preoperatively employed and had available data, 75% (n = 7518) returned to work at 1 yr (Table 2). Multivariable logistic regression analyses found that leg pain predominance compared to back pain predominance was significantly associated with higher odds of return to work (OR = 1.28, 95% CI = 1.02-1.61, $P = .03$); however, presence of equal leg and back pain compared to predominant back pain (OR = 1.18, 95% CI = 0.98-1.41, $P = .07$) was not significantly associated with return to work. Severity of back pain was associated with lower odds of return to work (NRS-BP: OR: 0.92, 95% CI = 0.89-0.96, $P < .0001$), whereas NRS-LP was not associated with return to work (OR: 0.98, 95% CI = 0.95-1.02, $P = .3$) (Table 4).

Workers compensation (Wald χ^2 114, accounting for 20% of total χ^2) and type of occupation (Wald χ^2 92.1, accounting for 16.3% of total Wald χ^2) were top predictors of return to work. Baseline NRS-BP was a relatively less important predictor (Wald $\chi^2 = 16.7$, accounting for 2.9% of total χ^2), whereas predominant symptom (Wald $\chi^2 = 4.9$, accounting for 0.8% of total χ^2), symptom duration (Wald $\chi^2 = 4.0$, accounting for 0.7% of total χ^2), and baseline NRS-LP (Wald $\chi^2 = 0.9$, accounting for 0.1% of total χ^2) were not important predictors of return to work at 1 yr (Figure 3).

Patient Satisfaction at 1 Year

Overall, 83.8% (n = 18 462) of patients were satisfied (NASS satisfaction = 1 or 2) with their surgical outcome at 1 yr. Multivariable proportional odds regression analyses found that

TABLE 4. Multivariable Logistic Regression to Assess Impact of Dominant Symptom on Return to Work at 12 Months

Variable	OR* (95% CI)	*P* value
Age	0.97 (0.96-0.98)	**.0005**
Sex		
Female	0.76 (0.66-0.88)	**.0003**
Male	Reference	Reference
Race		
Caucasian	Reference	Reference
African-American	0.56 (0.45-0.70)	**<.0001**
Other	0.63 (0.42-0.93)	**.02**
Ethnicity		
Hispanic	1.12 (0.70-1.80)	.62
Non-Hispanic	Reference	
Education		
Postcollege	1.78 (1.17-2.69)	**.006**
Four-year college	1.42 (0.97-2.09)	.07
Two-year college	1.17 (0.81-1.70)	.40
High school	0.99 (0.69-1.40)	.91
Less than high school	Reference	Reference
Insurance		
Medicare	1.44 (0.78-2.66)	.24
Medicaid	0.89 (0.46-1.72)	.74
VA/Govt.	1.82 (0.91-3.65)	.08
Private	1.98 (1.12-3.51)	.02
Uninsured	Reference	Reference
Worker's compensation		
Yes	0.30 (0.24-0.37)	**<.0001**
No	Reference	Reference
Employment type		
Light	0.78 (0.63-0.96)	.02
Medium	0.51 (0.42-0.62)	**<.0001**
Heavy	0.39 (0.32-0.49)	**<.0001**
Sedentary	Reference	
Predominant pain location		
Back pain	Reference	Reference
Leg pain	1.28 (1.02-1.60)	**.03**
Equal back and leg pain	1.18 (0.98-1.41)	.07
Symptom duration		
<3 mo	1.26 (1.00-1.57)	.04
>3 mo	Reference	Reference
Baseline NRS-BP	0.92 (0.89-0.96)	**<.0001**
Baseline NRS-LP	0.98 (0.95-1.02)	.34
Preop ambulation		
Independent	Reference	Reference
With assist device	0.65 (0.55-0.78)	**<.0001**
Motor deficit	0.80 (0.69-0.94)	.005
BMI	0.99 (0.98-1.01)	.80
Current smoker	0.66 (0.55-0.78)	**<.0001**
Depression	0.73 (0.59-0.88)	**.001**
Anxiety	0.93 (0.75-1.14)	.5
Diabetes	1.01 (0.83-1.23)	.9
CAD	0.90 (0.71-1.15)	.4
ASA grade		
≤2	Reference	Reference
>2	0.62 (0.52-0.74)	**<.0001**
Fusion	0.53 (0.45-0.61)	**<.0001**
Surgical approach		
Posterior only	Reference	Reference
Anterior only	1.14 (0.66-1.97)	.63
Lateral only	0.66 (0.38-1.14)	.14
Two-stage	0.84 (0.56-1.27)	.41
No. of levels	1.01 (0.93-1.10)	.82

*Odds Ratios for continuous variables (age, BMI, baseline NRS-BP, NRS-LP, no. of levels) are expressed as interquartile range odds ratios.
Bold values indicates statistical significance at $P \leq .05$.

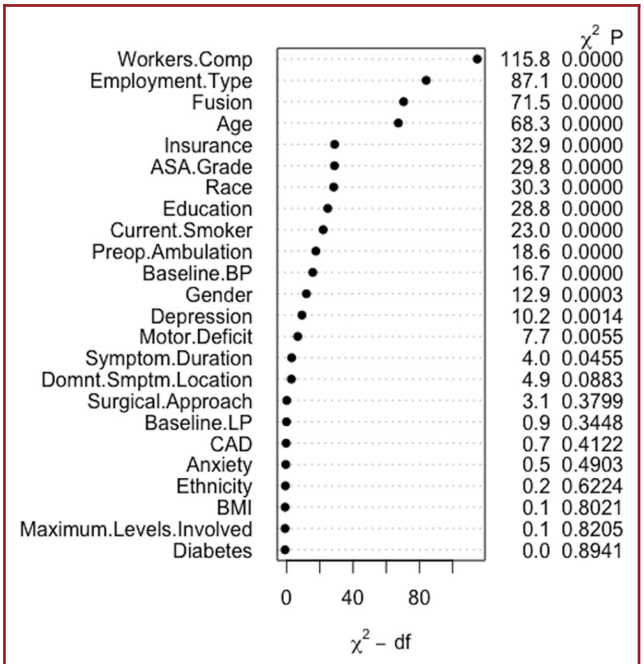

FIGURE 3. *Relative predictive importance analysis for the multivariable logistic regression model for return to work at 12 mo.*

presence of predominant leg pain (OR = 1.23, CI = 1.12-1.35, $P < .001$) and equal leg and back pain (OR = 1.21, CI = 1.12-1.31, $P < .001$) compared to predominant back pain were associated with higher odds for achieving satisfaction (ref = back pain predominant) (Table 5). Higher NRS-BP (OR = 0.95, CI = 0.93-0.95, $P < .001$) was significantly associated with lower odds, whereas NRS-LP was associated with greater odds of achieving satisfaction (OR = 1.01, CI = 1.0-1.28, $P = .049$).

Worker's compensation (Wald χ^2 106, 16.7% of total χ^2) and insurance status (Wald χ^2 82, 13% of total χ^2) were top predictors of 1-yr satisfaction. Baseline NRS-BP (Wald χ^2 57.6, 9.1% of total χ^2) and symptom duration (Wald χ^2 53.1, 8.4% of total χ^2) were also important predictors of achieving satisfaction.

TABLE 5. Multivariable Ordinal Regression to Assess Impact of Dominant Symptom on Odds of Achieving Satisfaction

Variable	OR* (95% CI)	*P* value
Age	1.0 (0.99-1.004)	.1
Sex		
Female	1.0 (0.95-1.06)	.8
Male	Reference	Reference
Race		
Caucasian	Reference	Reference
African-American	0.70 (0.62-0.76)	**<.0001**
Other	0.84 (0.72-0.99)	.035
Ethnicity		
Hispanic	1.05 (0.87-1.26)	.6
Non-Hispanic	Reference	Reference
Education		
Postcollege	1.63 (1.42-1.88)	**<.0001**
Four-year college	1.48 (1.30-1.70)	**<.0001**
Two-year college	1.40 (1.23-1.60)	**<.0001**
High school	1.24 (1.10-1.40)	**.0003**
Less than high school	Reference	Reference
Insurance		
Medicare	1.30 (0.98-1.72)	.06
Medicaid	0.78 (0.58-1.04)	.09
VA/Govt.	1.12 (0.82-1.52)	.5
Private	1.36 (1.04-1.79)	**.02**
Uninsured	Reference	Reference
Worker's compensation		
Yes	0.43 (0.43-0.57)	**<.0001**
No	Reference	Reference
Predominant pain location		
Back pain	Reference	Reference
Leg pain	1.23 (1.13-1.35)	**<.0001**
Equal back and leg pain	1.21 (1.12-1.31)	**<.0001**
Symptom duration		
<3 mo	1.41 (1.29-1.56)	**<.0001**
>3 mo	Reference	Reference
Baseline NRS-BP	0.95 (0.93-0.96)	**<.0001**
Baseline NRS-LP	1.01 (0.99-1.03)	.05
Preop ambulation		
Independent	Reference	Reference
With assist device	0.91 (0.83-0.99)	.02
Motor deficit	0.94 (0.89-1.003)	.07
BMI	0.99 (0.98-0.99)	.04
Current smoker	0.72 (0.67-0.78)	**<.0001**
Depression	0.95 (0.87-1.02)	.1
Anxiety	0.85 (0.78-0.93)	**.0001**
Diabetes	0.98 (0.91-1.06)	.7
CAD	0.96 (0.88-1.05)	.3
ASA grade		
≤2	Reference	Reference
>2	0.79 (0.74-0.85)	
Fusion	1.07 (1.01-1.13)	**.03**
Surgical approach		
Posterior only	Reference	Reference
Anterior only	0.85 (0.68-1.06)	.1
Lateral only	1.60 (1.23-2.08)	**.0004**
Two-stage	0.89 (0.75-1.05)	.2
No. of levels	0.97 (0.93-1.0)	**.02**

*Odds Ratios for continuous variables (age, BMI, baseline NRS-BP, NRS-LP, no. of levels) are expressed as interquartile range odds ratios.
Bold values indicates statistical significance at $P \leq .05$.

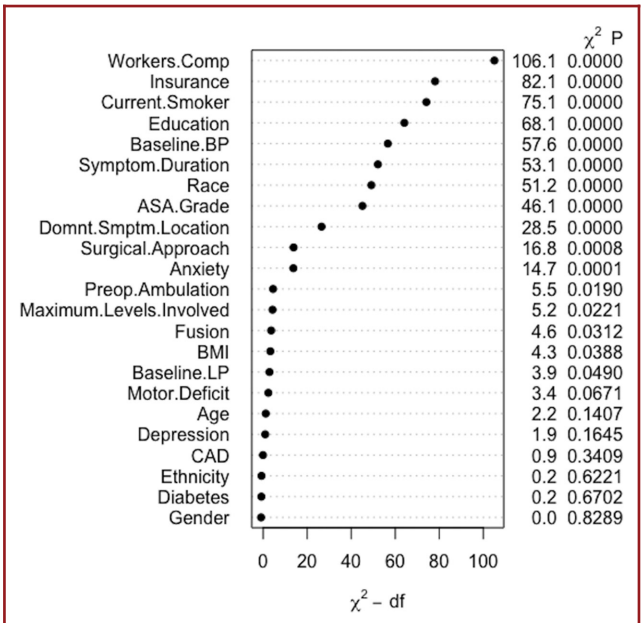

FIGURE 4. *Relative predictive importance analysis for the multivariable logistic regression model for achieving satisfaction with surgery at 12 mo.*

Dominant symptom location was a relatively less important determinant of satisfaction (Wald χ^2 28.5, 4.5% of total χ^2) (Figure 4).

DISCUSSION

In this analysis of 22 022 patients undergoing elective lumbar spine surgery from the QOD, we determined the impact of predominant symptom on patient outcomes at year following lumbar spine surgery. Overall, we found dominant symptom to be a statistically significant predictor of most 1-yr outcomes but relatively less important compared to other predictors.

Functional Disability and Quality of Life

We observed that location of predominant symptoms was significantly associated with PROs measuring improvement in disability (ODI) and quality of life (EQ-5D). Leg pain predominant symptoms and higher NRS-LP were associated with favorable odds for achieving clinically important improvement in disability and improvement in quality of life. Our analysis revealed that severity of leg pain (as indicated by NRS-LP) at baseline and symptom duration were the 2 most important predictors of both improvement in disability and quality of life, with higher leg pain severity and shorter symptom duration associated with higher improvement. McGirt et al[10] found similar results in QOD data wherein back pain predominance was associated with a lower 12-mo ODI, although MCID was not assessed in that study. We found that baseline severity of back pain was not significantly associated with odds of achieving MCID.

Therefore, it might be argued that higher severity of back pain does not necessarily impact a patient's ability to achieve a clinically significant difference in disability following surgery. It might be reasonable to conclude that pain intensity and duration have a stronger influence compared to location of pain on improvement in functional disability.

Satisfaction With Surgery

We noted that patients with predominant leg pain or equal leg pain and back pain had higher odds of being satisfied following surgery compared with patients with predominant back pain. Satisfaction was lower in patients with higher severity of back pain (NRS-BP), whereas higher odds were noted with higher baseline leg pain (NRS-LP). Combined, these findings may indicate that satisfaction is higher in patients with a higher leg pain component. However, factors like worker's compensation, smoking status, insurance, and education status were found to be relatively more important in terms of predicting 12-mo satisfaction. In addition, baseline severity of back pain (as measured by NRS-BP) and duration of symptoms also had higher predictive importance, in tandem with our previous results. These results are consistent with a prior analysis by Chotai et al,[13] which showed the dominant symptom to be a poor (but statistically significant) predictor of patient satisfaction at 2 yr postoperatively. In terms of predictor importance, severity, and duration of pain, symptoms were more important determinants compared to pain location.

Return to Work

Although our findings cumulatively suggest a possibly lower return to work in patients with severe predominant back pain, predominant symptom location was not found to be an important predictor of return to work relative to other predictors. Baseline NRS-BP and symptom duration had higher predictor importance as compared to predominant symptom location; however, these metrics were relatively far less important as compared with other predictors such as worker's compensation, type of employment, fusion, age, and insurance status (Figure 3). Worker's compensation and type of compensation were found to be most important predictors of return to work. These results are consistent with prior analyses from a prospective single-institutional spine registry by McGirt et al[21] (n = 1803) and a smaller cohort of subjects enrolled in the QOD by Asher et al[22] (n = 4694). This suggests that likelihood of returning to work is more related to preoperative employment and sociodemographic characteristics. Although predominant symptom location was not an important predictor, presence of motor deficits and assisted preoperative ambulation at baseline were found to be significant negative predictors of likelihood to return to work. These factors also carried higher predictor importance compared to symptom duration, severity, and location. Similar results were observed by Devin et al[23] in an analysis of the cervical module of the QOD wherein subjects with myelopathy were found to have a lower odds of returning to work at 3 mo following surgery compared with subjects with isolated arm pain or neck pain without myelopathy. In summary, this suggests that presence of neurological deficits and degree of functional independence at baseline might be more relevant considerations for return to work compared to location and severity of preoperative symptoms.

Surgical Decision Making in Relation to Predominant Symptom

Although there is no defined dogma, there is some evidence to suggest that patients with back pain predominance might respond better to fusion, whereas radicular leg pain might respond more effectively to decompression alone.[24] Therefore, although dominant symptom itself may not be a strong determinant of 1-yr outcomes, it might indirectly play an important role depending on the surgical approach utilized.

Predominant symptom may also have an impact on quality of life. There are some notable studies in the cervical spine literature that evaluate the impact of dominant symptom on patient outcomes. In a cross-sectional study of 1809 subjects from the National Spine Network, Daffner et al[25] observed that subjects with combined axial neck pain and radicular arm pain had significantly lower quality of life (on all domains of 36-Item Short-Form Health Survey [SF-36] questionnaire) compared to subjects with either symptom alone. Younger patients (younger than 40 or 40-60 yr) were also more likely to be affected by these symptoms than patients older than 60 yr. In another cohort of 398 subjects with cervical radiculopathy from a single institution, Passias et al[26] sought to determine the impact of arm pain vs neck pain (arm pain to neck pain ratio, ANR) on postoperative PROs. The authors observed that subjects with ANR ≤ 1 were less likely to report improvement in their 2-yr postoperative NDI and SF-36 Physical Component Scores (PCS). Conversely, patients who reported greater arm pain than neck pain at baseline had higher odds of improvement in postoperative arm pain and SF-36 PCS. We found analogous results that higher leg pain was associated with more improvement in disability and quality of life. However, we found that sociodemographic factors and baseline symptom severity and duration might carry higher predictive importance for patients undergoing lumbar spine surgery.

Strengths and Limitations

The present study is the first to assess the impact of dominant symptom location in patients undergoing elective lumbar spine surgery after adjusting for a multitude of pertinent covariates. The lumbar module of the QOD serves as a national spine registry enrolling patients from over 74 participating sites across 26 states of the United States via representative sampling, which increases the generalizability of our findings.[13] We conducted a robust analysis with adjustment for multiple covariates. However, there were limitations to our analysis. First, despite adjusting for a variety of covariates, there is a possibility of residual confounding, which might impact the association between the primary predictor (dominant symptom) and outcomes. Second, missing data for some of the covariates was also a limitation.

However, we found missing data to be <10%, which allowed multiple imputation to be performed without significant concern.

CONCLUSION

Predominant leg pain and equal leg and back pain are statistically significant determinants of improvement in disability, quality of life, and patient satisfaction following elective lumbar spine surgery. However, severity and duration of pain symptoms might have higher predictive importance for these outcomes. By contrast, return to work following surgery is more dependent on sociodemographic features as compared to symptom characteristics.

Disclosures

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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COMMENT

In this article, the authors retrospectively reviewed patients undergoing elective degenerative lumbar spine surgery to determine the impact of preoperative symptom location, severity, and duration on postoperative improvement in disability, quality of life, return to work, and patient satisfaction at 1-year follow-up. The authors found 22 022 patients in the Quality Outcomes Database (QOD) with data concerning preoperative pain location (as measured by predominant leg or back pain, or equal leg and pain back), severity [as measured by Numeric Rating Scale leg pain (NRS-LP) or back pain], and duration. Clinical outcomes at 1-year follow-up were measured by the Oswestry Disability Index (ODI), EuroQual-5d (EQ-5D), North American Spine Society (NASS) satisfaction questionnaire, and return to work.

The authors found that predominant preoperative leg pain was more likely to result in a minimal clinically important significant difference (MCID) in ODI and return to work. Patients with equal preoperative leg and back pain had significant improvement in the NASS satisfaction questionnaire. NRS-LP and symptom duration were key predictors in achieving MCID improvement in EQ-5D. It would have been interesting for the authors to compare the outcomes of minimally invasive and traditional open surgeries.

This work is clinically significant as it helps surgeons stratify which patients may benefit from surgery and set patients' postoperative expectations. The authors are commended for their contribution.

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