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Patient-Reported Allergies Do Not Affect Long-Term Patient-Reported Outcome Measures After Spine Surgery

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ABSTRACT

Background: A gap in the literature exists regarding the association between number of allergies and patient-reported outcomes measures (PROMs) for patients undergoing spine surgery.

Methods: Consecutive cervical or lumbar spine surgery patients were identified from a prospective registry from April 2017 to July 2020. Patients were grouped into those with 0, 1, 2, or ≥3 allergies. Demographics were compared between the groups. PROMs included Neck Disability Index, Oswestry Disability Index, visual analog scale (VAS) neck pain, VAS arm pain, VAS back pain, VAS leg pain, short form 12 (SF-12) physical component score, SF-12 mental component score, and patient-reported outcomes measurement information system physical function (PROMIS-PF), and outcomes were compared between the groups through multivariable analysis at up to 1-year follow-up. Associations between number of allergies and achieving a minimal clinically important difference (MCID) in the 9 aforementioned PROMs at 1-year follow-up were assessed.

Results: This study included 148 cervical and 517 lumbar patients. After controlling for demographic differences, a higher number of allergies was associated with less improvement in VAS neck pain, SF-12 physical component score, and PROMIS-PF at 12 weeks following cervical surgery and less improvement in PROMIS-PF at 2 weeks following lumbar surgery ($P < 0.05$). However, these associations failed to persist after 6 months and 12 weeks following surgery in cervical and lumbar patients, respectively ($P > 0.05$). No association was identified between number of allergies and achievement of MCID in any of the 9 studied PROMs at 1-year follow-up.

Conclusions: The higher number of allergies was associated with less improvement in PROMs in the early postoperative period but not at longer-term follow-up.

Clinical Relevance: These findings provide data that can be utilized while counseling patients and setting postoperative expectations.

Level of Evidence: 3.

Minimally Invasive Surgery

Keywords: patient-reported allergies, spine surgery, cervical, lumbar, patient-reported outcome measures, minimal clinical important difference

INTRODUCTION

There has been recent interest in studying the association between patient-reported allergies and postoperative outcomes.[1] Various orthopedic subspecialties, such as total joint arthroplasty, have evaluated this association and have shown that patients with multiple reported allergies have less improvement in postoperative patient-reported outcome measures (PROMs) compared with patients with fewer allergies.[2] With a recent shift in orthopedic surgery from fee-for-service to value-based care, it is important to understand these associations as poorer outcomes can now be translated to decreased reimbursement.[3] This is especially important to consider when poorer outcomes may be due to patient preoperative nonmodifiable factors.

When looking specifically at the effects of the number of patient-reported allergies on postoperative PROMs in the field of spinal surgery, data in the literature have been limited and mixed.[1,4] A few published abstracts, without associated full-text articles, have shown an association between increasing number of allergies and less improvement in postoperative PROMs such as Oswestry Disability Index (ODI) and short form 12 (SF-12) at up to 1-year follow-up.[5,6] However, a recent full-text article demonstrated that a greater number of allergies may actually be associated with improved short-term postoperative pain and disability burden while having no effect on these outcomes at 1-year follow-up.[4]

Due to this lack of comprehensive data in the literature, the purposes of the current study were to determine the effects of the number of patient-reported allergies on postoperative PROMs and on achieving a minimal clinically important difference (MCID) at 1 year after cervical or lumbar spine surgery.

MATERIALS AND METHODS

Study Design and Population

A retrospective review of prospectively collected data from a surgical database from April 2017 to July 2020 was performed. A fellowship-trained attending spine surgeon performed all procedures, and the first assist was a spine fellow for more than 85% of cases; in the remaining cases, it was an orthopedic surgery resident.

Consecutive patients who underwent cervical spine surgery or lumbar spine surgery from April 2017 to July 2020 were selected. Details of the surgical techniques have been extensively described in previous articles and book chapters.[7–10] Each patient's preoperative diagnosis was characterized. All revision cases were excluded. A total of 148 cervical spine surgery and 517 lumbar spine patients were identified. Institutional review board approval was obtained for this study.

Data Collection

Data were collected and managed using Research Electronic Data Capture (REDCap)[11,12] hosted at Weill Cornell Medicine Clinical and Translational Science Center, supported by the following grant: CTSC GRANT UL1 TR002384. REDCap is a secure, Health Insurance Portability and Accountability Act of 1996 compliant web-based software platform designed to support data capture for research studies. Patient demographics, comorbidities, preoperative diagnosis, procedure type, and PROMs were obtained from review of electronic medical records and REDCap. In addition, the total number of allergies for each patient was collected from medical records, and patients were categorized to those with 0, 1, 2, or ≥3 allergies. The total number of allergies for each patient was also subcategorized into medical or environment/food/other allergies.

Demographics and comorbidities data included age, gender, body mass index, insurance type, preoperative narcotic use, current smoking status, diabetes, hypertension, Charlson Comorbidity Index (CCI), American Society of Anesthesiologists (ASA) Classification, percentage neck pain, percentage back pain, percentage radiculopathy, preoperative depression, preoperative anxiety, and preoperative affective disorder.

Last, PROMs were recorded preoperatively and at 2-week, 12-week, 6-month, and 1-year follow-up visits. Assessments exclusively for cervical spine surgery patients included the Neck Disability Index (NDI), visual analog scale (VAS) neck pain, and VAS arm pain. Assessments exclusively for lumbar spine surgery patients included the ODI, VAS back pain, and VAS leg pain. Assessments for all patients included the SF12 physical component score (PCS), SF12 mental component score (MCS), and patient-reported outcomes measurement information system physical function (PROMIS-PF). These PROMs have all been validated for use in this patient population.[13,14]

Statistical Methods

Patient demographics, comorbidities, preoperative diagnosis, procedure, and preoperative PROMs were summarized using descriptive statistics. Categorical variables were summarized as frequency (percentage) while continuous variables were summarized as mean ± SD. In addition, these variables were also compared between those with 0, 1, 2, or ≥3 total allergies using Fisher's exact test, Pearson's χ^2 test, or analysis of variance, where appropriate.

Multivariable linear regressions were used to evaluate the association between increasing number of total allergies and each of the 9 studied PROMs at 2-week, 12-week, 6-month, and 1-year follow-up. For each of these regressions, pertinent covariates were included to adjust for confounding and to minimize bias. For example, for cervical spine surgery patients, gender, CCI, ASA, and preoperative PROMIS-PF were found to be statistically different between those with 0, 1, 2, or ≥3 allergies, and these variables were controlled for in the multivariable linear regressions. For lumbar spine surgery patients, gender, CCI, ASA, and preoperative depression were found to be statistically different between those with 0, 1, 2, or ≥3 allergies, and these variables were controlled for in the multivariable linear regressions. The decision to utilize multivariable linear regressions was based on a previous similar study.[4]

To further characterize the clinical significance of changes as measured on these PROMs, the MCID was determined for each instrument. MCID for cervical spine patients was calculated for NDI, VAS neck pain, VAS arm pain, SF12-PCS, SF12-MCS, and PROMIS-PF. MCID for lumbar spine patients was calculated for ODI, VAS back pain, VAS leg pain, SF12-PCS, SF12-MCS, and PROMIS-PF. The distribution-based method, as

previously described in the literature, was used in this study.[15] Briefly, the threshold for achieving the MCID for each instrument was determined by calculating the change in outcome equal to 0.5 SD over a 1-year period. We considered any patient who met this threshold at 1-year follow-up to have reached the MCID.

Multivariable Poisson regressions with robust error variance were used to determine the association between number of allergies and achieving MCID in each PROM at 1-year follow-up. For cervical spine surgery patients, gender, CCI, ASA, and preoperative PROMIS-PF were found to be statistically different between those with 0, 1, 2, or ≥3 allergies, and these variables were again controlled for in the multivariable Poisson regressions. For lumbar spine surgery patients, gender, CCI, ASA, and preoperative depression were found to be statistically different between those with 0, 1, 2, or ≥3 allergies, and these variables were again controlled for in the multivariable Poisson regressions.

Statistical significance was set as $P < 0.05$. All statistical analyses were performed using STATA version 13 (StataCorp LP, College Station, TX).

RESULTS

Patient Population

A total of 148 patients who underwent cervical spine surgery and 517 patients who underwent lumbar spine surgery were identified for analysis based on the inclusion/exclusion criteria. Details of patient demographics, comorbidities, preoperative diagnosis, procedure type, and preoperative PROMs for each cohort can be found in Tables 1 and 2.

For cervical spine surgery patients, 86 (58%) had 0 allergies, 25 (17%) had 1 allergy, 15 (10%) had 2 allergies, and 22 (15%) had ≥3 allergies. For lumbar spine surgery patients, 266 (52%) had 0 allergies, 129 (25%) had 1 allergy, 48 (9%) had 2 allergies, and 74 (14%) had ≥3 allergies. Further subcategorization of total allergies into total medical allergies or total environment/food/other allergies is shown in Table 3.

Association Between Number of Total Allergies and Postoperative PROMs

For cervical spine patients, after controlling for any preoperative characteristic differences, an increasing number of allergies was associated with decreased improvement in VAS neck pain (β coefficient = 0.41, P = 0.009) and VAS arm pain (β coefficient = 0.39, P = 0.015) at 2-week follow-up. In addition, increasing number of allergies was associated with decreased improvement in VAS neck pain (β coefficient = 0.34, P = 0.009), SF-12 PCS (β coefficient = −1.84, P = 0.004), and PROMIS-PF (β coefficient = −1.41, P = 0.021)

Table 1. Characteristics of cervical spine surgery patients (N = 148).

Characteristic	*n* (%)
Age, y, mean ± SD	51.4 ± 12.3
Gender	
Men	98 (66.2%)
Women	50 (33.8%)
Body mass index, mean ± SD	27.4 ± 5.7
Insurance	
Medicare	16 (10.8%)
Workers' compensation	2 (1.4%)
Commercial/private	130 (87.8%)
Preoperative narcotic use	
No	129 (87.2%)
Yes	19 (12.8%)
Current smoker	
No	131 (89.1%)
Yes	16 (10.9%)
Diabetes	
No	6 (96.0%)
Yes	142 (4.1%)
Hypertension	
No	116 (78.4%)
Yes	32 (21.6%)
CCI	
0	119 (80.4%)
1	15 (10.1%)
≥2	14 (9.5%)
ASA classification	
1	24 (16.4%)
≥2	122 (83.6%)
Percentage neck pain, mean ± SD	37.8 ± 34.9
Percentage radiculopathy, mean ± SD	62.9 ± 34.4
Preoperative depression	
No	127 (85.8%)
Yes	21 (14.2%)
Preoperative anxiety	
No	122 (82.4%)
Yes	26 (17.6%)
Preoperative affective disorder	
No	146 (98.6%)
Yes	2 (1.4%)
Preoperative diagnosis	
Central stenosis	2 (1.4%)
Degenerative disc disease	2 (1.4%)
Degenerative spondylolisthesis	10 (6.8%)
Foraminal stenosis	15 (10.1%)
Herniated nucleus pulposus	3 (2.0%)
Kyphosis	5 (3.4%)
Myelopathy	75 (50.7%)
Radiculopathy	32 (21.6%)
Vertebral fracture	2 (1.4%)
Other	2 (1.4%)
Cervical procedure	
Cervical laminectomy/laminotomy/ laminoforaminotomy	5 (3.4%)
Cervical foraminal decompression	13 (8.8%)
Cervical discectomy	7 (4.7%)
Cervical total disc replacement	51 (34.5%)
Anterior cervical discectomy and fusion	69 (46.6%)
Posterior cervical fusion	3 (2.0%)
Preoperative PROMs, mean ± SD	
Neck Disability Index	35.4 ± 18.4
VAS neck pain	4.9 ± 3.0
VAS arm pain	4.7 ± 3.4
SF-12 PCS	37.5 ± 9.3
SF-12 MCS	47.9 ± 11.0
PROMIS	41.4 ± 7.8

Abbreviations: ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; PROM, patient-reported outcome measure; PROMIS, patient-reported outcomes measurement information system; SF-12 MCS, short form-12 mental component score; SF-12 PCS, short form-12 physical component score; VAS, visual analog scale.
Note: Data presented as n (%) except where otherwise noted.

Table 2. Characteristics of lumbar spine surgery patients (N = 517).

Characteristic	*n* (%)
Age, y, mean ± SD	57.1 ± 15.4
Gender	
Men	303 (58.6%)
Women	214 (41.4%)
Body mass index, mean ± SD	27.1 ± 5.3
Insurance	
Medicare	120 (23.2%)
Workers' compensation	4 (0.8%)
Commercial/private	385 (74.5%)
Medicaid	1 (0.2%)
Other	7 (1.4%)
Preoperative narcotic use	
No	401 (77.7%)
Yes	115 (22.3%)
Current smoker	
No	486 (94.0%)
Yes	31 (6.0%)
Diabetes	
No	483 (96.0%)
Yes	34 (4.1%)
Hypertension	
No	338 (78.4%)
Yes	179 (21.6%)
Charlson Comorbidity Index	
0	385 (74.5%)
1	59 (11.4%)
≥2	73 (14.1%)
American Society of Anesthesiologists classification	
1	65 (12.8%)
≥2	442 (87.2%)
Percentage back pain, mean ± SD	34.1 ± 33.5
Percentage radiculopathy, mean ± SD	66.0 ± 33.6
Preoperative depression	
No	452 (87.4%)
Yes	65 (12.6%)
Preoperative anxiety	
No	429 (83.0%)
Yes	88 (17.0%)
Preoperative affective disorder	
No	512 (99.0%)
Yes	5 (1.0%)
Preoperative diagnosis	
Cauda equina	2 (0.4%)
Central stenosis	4 (0.8%)
Degenerative disc disease	3 (0.6%)
Degenerative scoliosis	27 (5.2%)
Degenerative spondylolisthesis	23 (4.4%)
Discitis	2 (0.4%)
Facet cyst	35 (6.8%)
Flatback syndrome	6 (1.2%)
Foraminal stenosis	27 (5.2%)
Herniated nucleus pulposus	68 (13.2%)
Lateral recess stenosis	231 (44.7%)
Radiculopathy	66 (12.8%)
Spondylolysis	14 (2.7%)
Vertebral fracture	5 (1.0%)
Other	1 (0.2%)
Lumbar procedure	
Lumbar laminectomy/laminotomy/ laminoforaminotomy	38 (7.4%)
Lumbar foraminal decompression	73 (14.1%)
Lumbar discectomy	192 (37.1%)
Lumbar total disc replacement	4 (0.8%)
Transforaminal lumbar interbody fusion	109 (21.1%)
Lateral lumbar interbody fusion	17 (3.3%)
Anterior lumbar interbody fusion	21 (4.1%)
Posterior lumbar interbody fusion	63 (12.2%)
Preoperative PROMs, mean ± SD	
Oswestry Disability Index	39.9 ± 19.7
Vsual analog scale back pain	5.3 ± 3.1
Visual analog scale leg pain	5.8 ± 3.2
Short form-12 physical component score	32.7 ± 8.8
Short form-12 mental component score	47.3 ± 11.8
PROMIS	35.5 ± 7.8

Abbreviations: PROM, patient-reported outcome measures; PROMIS, patient-reported outcomes measurement information system.
Note. Data presented as *n* (%) except where otherwise noted.

Table 3. Prevalence of preoperative allergies.

Types of Allergies	*n* (%)
Cervical Spine	
Total	148 (100.0%)
Total allergies	
0	86 (58.1%)
1	25 (16.9%)
2	15 (10.1%)
≥3	22 (14.9%)
Total medical allergies	
0	103 (69.6%)
1	22 (14.9%)
2	13 (8.8%)
≥3	10 (6.8%)
Total environment/food/other allergies	
0	112 (75.7%)
1	24 (16.2%
2	4 (2.7%)
≥3	8 (5.4%)
Lumbar Spine	
Total	517 (100.0%)
Total allergies	
0	266 (51.5%)
1	129 (25.0%)
2	48 (9.3%)
≥3	74 (14.3%)
Total medical allergies	
0	324 (62.7%)
1	125 (24.2%)
2	37 (7.2%)
≥3	31 (6.0%)
Total environment/food/other allergies	
0	393 (76.0%)
1	77 (14.9%)
2	25 (4.8%)
≥3	23 (4.4%)

at 12-week follow-up (Table 4). There were no other significant associations between increasing number of allergies and postoperative PROMs at and after 6-months follow-up.

For lumbar spine patients, after controlling for any preoperative characteristic differences, increasing number of allergies was associated with decreased improvement in PROMIS-PF (β coefficient = −0.78, P = 0.002) at 2-week follow-up (Table 5). There were no other significant associations between increasing number of allergies and postoperative PROMs at and after 12-week follow-up.

Association Between Number of Total Allergies and Achieving MCID at 1 Year

For cervical spine patients, after controlling for any preoperative characteristic differences, there were no associations between total number of allergies and achieving MCID in any of the studied PROMs at 1-year follow-up (Table 6). These PROMs included NDI, VAS neck pain, VAS arm pain, SF12-PCS, SF12-MCS, and PROMIS-PF.

Similarly, for lumbar spine patients, after controlling for any preoperative characteristic differences, there

Table 4. Multivariable analysis of association between number of total allergies and patient-reported outcome measures in cervical spine surgery.

Cervical Spine	β Coefficient	P Value[a]
2-wk PROMs		
NDI	1.43	0.162
VAS neck pain	0.41	**0.009**
VAS arm pain	0.39	**0.015**
SF-12 PCS	−0.31	0.517
SF-12 MCS	0.30	0.596
PROMIS	−0.93	0.055
12-wk PROM		
NDI	1.06	0.293
VAS neck pain	0.34	**0.009**
VAS arm pain	0.04	0.796
SF-12 PCS	−1.84	**0.004**
SF-12 MCS	0.16	0.757
PROMIS	−1.41	**0.021**
6-mo PROM		
NDI	1.22	0.271
VAS neck pain	−0.002	0.990
VAS arm pain	−0.06	0.750
SF-12 PCS	−0.95	0.248
SF-12 MCS	−1.22	0.084
PROMIS	−1.03	0.167
1-y PROM		
NDI	0.20	0.899
VAS neck pain	0.19	0.406
VAS arm pain	0.03	0.893
SF-12 PCS	−0.35	0.732
SF-12 MCS	−0.14	0.857
PROMIS	−1.66	0.072

Abbreviations: ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; NDI, Neck Disability Index; PROM, patient-reported outcome measures; PROMIS, patient-reported outcomes measurement information system; SF-12 MCS, short form-12 mental component score; SF-12 PCS, short form-12 physical component score; VAS, visual analog scale.
[a]Multivariable linear regression controlling for gender, CCI, ASA, and preoperative PROMIS.

Table 5. Multivariable analysis of association between number of total allergies and patient-reported outcome measures in lumbar spine surgery.

Lumbar Spine	β Coefficient	P Value[a]
2-wk PROMs		
ODI	0.48	0.438
VAS back pain	−0.03	0.768
VAS leg pain	0.02	0.841
SF-12 PCS	−0.31	0.227
SF-12 MCS	0.58	0.066
PROMIS	−0.78	**0.002**
12-wk PROMs		
ODI	−0.003	0.996
VAS back pain	0.09	0.257
VAS leg pain	−0.01	0.916
SF-12 PCS	−0.32	0.363
SF-12 MCS	0.56	0.088
PROMIS	0.09	0.781
6-mo PROMs		
ODI	−0.33	0.653
VAS back pain	−0.05	0.637
VAS leg pain	0.01	0.889
SF-12 PCS	−0.15	0.727
SF-12 MCS	0.23	0.564
PROMIS	0.08	0.844
1-y PROMs		
ODI	0.6	0.420
VAS back pain	0.04	0.703
VAS leg pain	0.18	0.130
SF-12 PCS	−0.54	0.272
SF-12 MCS	0.65	0.160
PROMIS	0.38	0.395

Abbreviations: ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; ODI, Oswestry Disability Index; PROM, patient-reported outcome measure; PROMIS, patient-reported outcomes measurement information system; SF-12 MCS, short form-12 mental component score; SF-12 PCS, short form-12 physical component score; VAS, visual analog scale.
[a]Multivariable linear regression controlling for gender, CCI, ASA, and preoperative depression.

were no associations between total number of allergies and achieving MCID in any of the studied PROMs at 1-year follow-up (Table 7). These PROMs included ODI, VAS back pain, VAS leg pain, SF12-PCS, SF12-MCS, and PROMIS-PF.

DISCUSSION

Recently, there has been a growing interest in the relationship between patient-reported allergies and clinical outcomes after elective orthopedic surgery.[1,4,16–19] In spine surgery specifically, studies have shown varying levels of association between the number of allergies and PROMs.[1,4,19] The current study analyzed the relationship between the number of patient-reported allergies and postoperative PROMs after elective cervical and lumbar surgery. The current study found that, while controlling for other variables, the number of patient-reported allergies was associated with less improvement in PROMs in the early postoperative period for both cervical and lumbar spine patients. However, these associations failed to persist at and after 6 months and 12 weeks following surgery in cervical and lumbar patients, respectively. Furthermore, no significant association was seen between the number of allergies and achievement of MCID in any PROMs 1 year after surgery.

Previous studies have analyzed the impact of patient-reported allergies on postoperative outcomes after orthopedic surgery.[1,4,16–19] In a retrospective review, analyzing total knee arthroplasty and total hip arthroplasty patients, McLawhorn et al found that a greater number of patient-reported allergies were significantly associated with worse postoperative Western Ontario and McMaster Universities Osteoarthritis Index scores in both cohorts and longer length of hospitalization in the total knee arthroplasty cohort.[17] In regard to how patient-reported allergies contribute to postoperative pain medication usage, Coxe et al reported a significant positive relationship between the number of patient-reported allergies and postoperative opioid consumption in ambulatory hand surgery patients.[18]

Specifically in spine surgery, recent studies have also investigated this relationship between patient-reported

Table 6. Multivariable analysis of association between number of total allergies and achieving minimal clinically important difference at 1 y in cervical spine surgery.

Cervical Spine	RR	*P* Value[a]
Neck Disability Index		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1.15	0.717
2 Patient-reported allergies	1.29	0.597
≥3 Patient-reported allergies	1.11	0.843
VAS neck pain		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1.73	0.258
2 Patient-reported allergies	1.63	0.378
≥3 Patient-reported allergies	1.92	0.218
VAS arm pain		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.80	0.552
2 Patient-reported allergies	0.78	0.598
≥3 Patient-reported allergies	0.69	0.487
SF-12 PCS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1.48	0.446
2 Patient-reported allergies	1.60	0.425
≥3 Patient-reported allergies	1.56	0.467
SF-12 MCS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1.35	0.603
2 Patient-reported allergies	0.80	0.773
≥3 Patient-reported allergies	2.01	0.268
PROMIS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1.77	0.246
2 Patient-reported allergies	2.11	0.173
≥3 Patient-reported allergies	1.70	0.392

Abbreviations: ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; PROMIS, patient-reported outcomes measurement information system; Ref, reference; SF-12 MCS, short form-12 mental component score; SF-12 PCS, short form-12 physical component score; VAS, visual analog scale.
[a]Multivariable linear regression controlling for gender, CCI, ASA, and preoperative PROMIS.

Table 7. Multivariable analysis of association between number of total allergies and achieving minimal clinically important difference at 1 y in lumbar spine surgery.

Lumbar Spine	RR	*P* Value[a]
Oswestry Disability Index		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.94	0.793
2 Patient-reported allergies	1.04	0.876
≥3 Patient-reported allergies	1.05	0.883
VAS back pain		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.99	0.958
2 Patient-reported allergies	0.99	0.983
≥3 Patient-reported allergies	0.74	0.428
VAS leg pain		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.92	0.744
2 Patient-reported allergies	0.95	0.844
≥3 Patient-reported allergies	0.99	0.976
SF-12PCS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.68	0.081
2 Patient-reported allergies	0.62	0.064
≥3 Patient-reported allergies	0.8	0.494
SF-12 MCS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	0.93	0.853
2 Patient-reported allergies	1.13	0.773
≥3 Patient-reported allergies	2.11	0.092
PROMIS		
0 Patient-reported allergies	Ref	
1 Patient-reported allergy	1	0.987
2 Patient-reported allergies	1.06	0.816
≥3 Patient-reported allergies	0.92	0.821

Abbreviations: ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; PROMIS, patient-reported outcomes measurement information system; Ref, reference; SF-12 MCS, short form-12 mental component score; SF-12 PCS, short form-12 physical component score; VAS, visual analog scale.
[a]Multivariable linear regression controlling for gender, CCI, ASA, preoperative depression

allergies and PROMs. In the preoperative setting, Lyons et al found a significant negative association between the number of patient-reported allergies and various preoperative PROMs, including ODI, NDI, PROMIS physical health, and PROMIS mental health.[1] In the postoperative time period, the literature has shown mixed results and lacks data on a variety of PROMs.[5] Levin et al studied 421 patients and showed that patient-reported allergies were associated with lower patient satisfaction scores, as measured with the Hospital Consumer Assessment of Healthcare Providers and Systems survey, after lumbar spine surgery.[19] Xiong et al interestingly reported a significant association between the number of patient-reported allergies and subjective improvement in postoperative pain and disability burden as measured by the pain disability questionnaire in the early postoperative period after cervical and lumbar spine surgery.[4] This association failed to persist 1 year after surgery. However, both of these published studies failed to evaluate any association between increasing number of allergies and validated postoperative PROMs such as NDI, ODI, VAS pain, SF-12, and PROMIS.

To the best of our knowledge, this is the first study to explore the impact of patient-reported allergies on an extensive list of postoperative validated PROMs in both cervical and lumbar spine surgery. The results of this study demonstrated some similarities with those of previous studies that analyzed the impact of allergies in spine surgery. For example, Xiong et al found no significant association between the number of allergies and clinical outcomes at 1 year postoperatively.[4] However, the results of this study also differed with previous studies in several aspects. For example, Xiong et al found a significant association between the number of patient-reported allergies and subjective improvement in pain and disability burden in the early postoperative period.[4] In contrast, this study found that the number of patient-reported allergies was significantly associated with worse PROMs in the early postoperative period. Combined, the results of this study can be used for effective patient counseling: Although allergies may

lead to potentially worse outcomes in the short term following surgery, they do not impact long-term outcomes or the ability to achieve meaningful clinical improvement 1 year following surgery.

Many explanations regarding the impact of allergies on postoperative outcomes have been proposed in prior studies. A notable theory is that the relationship among preoperative mental health, patient-reported allergies, and postoperative outcomes may play a role. It has been well established in the literature that preoperative psychiatric conditions such as depression and anxiety may negatively impact outcomes after spine surgery.[20,21] Furthermore, numerous studies have reported a significant association between preoperative depression/anxiety and the number of patient-reported allergies.[6,19] Therefore, it can be reasoned that patients with greater allergy burden may also exhibit greater comorbid psychiatric burden, which may be contributing to worse outcomes. However, the current study has already controlled for various preoperative variables that were significantly different among the population, including preoperative depression in lumbar spine patients. Hence, it can be suggested that the number of patient-reported allergies may be an independent predictor for short-term outcomes after spine surgery, irrespective of factors such as preoperative mental health.

The current study had inherent limitations. This was a retrospective review of prospectively collected data, which potentially introduces selection bias to the study. All surgeries were performed by a single surgeon at an academic institution, thus limiting the external validity of the results to other populations. All allergies were self-reported on clinical intake forms, signifying that some patients may not have had a proper clinical diagnosis. Thus, the study's reported prevalence of allergies may not reflect the true prevalence within this sample population. Furthermore, patients with allergies can present with a wide range of clinical manifestations, and it may be possible that the severity and type of reaction to allergies may influence postoperative outcomes. This study had no reliable source of information regarding these potential differences in clinical presentation. Therefore, future studies may need to further stratify based on more granular information. In addition, due to the retrospective nature of the current study as well as limited sample size, there is potential for Type II error.

CONCLUSION

The present retrospective study analyzed the association between the number of patient-reported allergies and postoperative patient-reported outcomes after cervical and lumbar spine surgery. In the early postoperative period, a greater number of allergies were associated with less improvement in various outcome measures. This association, however, did not persist after 6 months in either surgical population. The number of patient-reported allergies had no significant impact on achieving clinically meaningful improvement in any outcome measure at 1 year following surgery. These findings can be used to counsel patients with self-reported allergiesregarding expectations on postoperative outcomes.

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