

# Comparison of postoperative complications and outcomes following primary versus revision discectomy: A national database analysis

## ABSTRACT

**Background:** Lumbar microdiscectomy is a surgical procedure that is frequently used in the treatment of symptomatic lumbar herniation. Differences in outcomes following primary and revision lumbar microdiscectomy have been previously studied, with reports of comparably satisfactory results from the Spine Patient Outcomes Research Trial. In this study, we further investigate these outcomes, including length of stay, bleeding events, and durotomy. We hypothesized that length of stay, incidence of bleeding events, and dural tear would be greater in the revision cohort.

**Methods:** The ACS-National Surgical Quality Improvement Program database was queried for patients undergoing single-level primary and revision lumbar microdiscectomy between 2019 and 2022. Eligibility for inclusion was determined by age >18 years and current procedural terminology codes 63030 and 63042. Patients with preoperative sepsis or cancer were excluded. Length of stay, wound infection, bleeding events requiring transfusion, cerebrospinal fluid leak, dural tear, and neurological injury were compared between the cohorts. Multivariable Poisson regression adjusted for demographics and comorbidities, including age, sex, race, body mass index, diabetes, smoking, and hypertension, was used to determine if revision was predictive of complications.

**Results:** A total of 37,669 patients were included, of whom 3,635 (9.6%) required revision surgery. Patients in the revision cohort were older ( $54.25 \pm 15.7$  vs.  $50.85 \pm 16.0$  years,  $P < 0.001$ ) and had higher proportions of male (59.0% vs. 55.7%,  $P < 0.001$ ) and non-Hispanic White patients (82.0% vs. 77.4%,  $P < 0.001$ ). Length of stay ( $1.11 \pm 2.5$  vs.  $1.58 \pm 2.7$ ,  $P < 0.001$ ) and rates of wound infection (2.1% vs. 1.4%,  $P = 0.002$ ) and bleeding events requiring transfusion (1.3% vs. 0.7%,  $P < 0.001$ ) were greater in the revision cohort compared to primary patients. Differences in cerebrospinal fluid leak (0.2% vs. 0.1%,  $P = 0.116$ ), dural tear complication (0.01% vs. 0.01%,  $P = 0.092$ ), and neurological injury (0.008% vs. 0.006%,  $P = 0.691$ ) between the revision and primary cohorts were nonsignificant. Poisson log-linear regression adjusted for demographics and comorbidities demonstrated revision as a significant predictor for length of stay ( $\chi^2 = 462.95$ ,  $P < 0.001$ ), wound infection ( $\chi^2 = 9.22$ ,  $P = 0.002$ ), and bleeding events ( $\chi^2 = 9.74$ ,  $P = 0.002$ ), while it was a nonsignificant predictor of cerebrospinal fluid leak ( $\chi^2 = 2.61$ ,  $P = 0.106$ ), dural tear ( $\chi^2 = 2.37$ ,  $P = 0.123$ ), and neurological injury ( $\chi^2 = 0.229$ ,  $P = 0.632$ ).

**Conclusion:** Revision surgery was a significant predictor of increased length of stay, wound infection, and bleeding events requiring transfusion. Surgeons and patients alike should be aware of increased risk for complications following revision lumbar microdiscectomy compared to primary discectomy.

**Keywords:** Bleeding, cerebrospinal fluid leak, complication, discectomy, dural tear, durotomy, lumbar, microdiscectomy, neurological injury, National Surgical Quality Improvement Program, revision, Spine Patient Outcomes Research Trial

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## INTRODUCTION

Lumbar disc herniation commonly causes symptomatic lumbar radiculopathy. Operative management has been shown to improve pain and function and has superior long-term clinical outcomes than nonoperative management.<sup>[1]</sup> Lumbar microdiscectomy is an effective surgical procedure for the treatment of symptomatic disc herniation, with success rates of 80%–90%.<sup>[2–4]</sup> However, reherniation is common, occurring in 5%–21% of patients following primary lumbar discectomy and is the leading cause of reoperation for this procedure.<sup>[5–10]</sup> The majority of recurrent herniations occur at the same level as the index procedure.<sup>[1]</sup>

Revision microdiscectomy has a higher level of technical difficulty and has been associated with higher complication rates than primary microdiscectomy.<sup>[11]</sup> However, this varies by the specific type of complication. For example, the Spine Patient Outcomes Research Trial (SPORT) found that revision microdiscectomy patients had a higher rate of postoperative wound infections and a longer length of stay than primary microdiscectomy patients. However, no differences between the two groups were observed for durotomy, intraoperative or postoperative nerve root injury, or wound hematoma.<sup>[11]</sup> In contrast, Morgan-Hough *et al.* and Papadopoulos *et al.* reported a higher incidence of durotomy for revision procedures than primary (14.3% revision vs. 5.5% primary and 8.1% vs. 3.1%, respectively).<sup>[12,13]</sup> However, both of these studies were single center and thus did not utilize a nationally representative sample. Phan *et al.* utilized a national database and found no difference in overall complication rate or wound complications in the 30-day postoperative period.<sup>[14]</sup> However, the study did not investigate specific complications such as durotomy, wound infection, or neurological injury. As such, the purpose of this study is to further investigate these specific complications and compare them between primary and revision lumbar microdiscectomy patients utilizing a large, national database. We hypothesized that length of stay, incidence of bleeding events, and incidence of dural tears would be greater in the revision cohort than the primary cohort.

## METHODS

### Study design and data source

This retrospective, observational study analyzed patients who underwent single-level primary and revision lumbar microdiscectomy between 2019 and 2022. Data were sourced from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database, an anonymized, outcome-based registry encompassing information from over 700 participating institutions.<sup>[15,16]</sup>

Patient baseline demographics and 30-day perioperative outcome data were directly recorded from the electronic medical records by clinical reviewers and were risk-adjusted based on the patient characteristics to account for population differences. The database undergoes regular auditing to maintain accuracy and validity.<sup>[17,18]</sup>

### Study population

Adult patients over the age of 18 years who underwent single-level primary lumbar discectomy were identified using current procedural terminology (CPT) code 63030, while patients undergoing revision lumbar discectomy were identified using CPT code 63042. Patients with preoperative sepsis or cancer were excluded from this study.

### Outcome measures

The primary outcomes of interest included length of stay, wound infection, bleeding events requiring transfusion, cerebrospinal fluid leak, dural tear, and neurological injury. These outcomes were compared between the primary and revision cohorts. Cerebrospinal fluid leak, dural tear, and neurological injury were identified using the International Classification of Diseases, Tenth Revision (ICD-10) codes for reoperation. ICD-10 codes G96.0, G96.08, and G96.09 were used to identify cerebrospinal fluid leak, G96.11 and G97.41 for dural tear, and G97.8 and G97.82 for neurological injury.

### Demographics and comorbidities

Patient demographics and comorbidities were recorded, including age, sex, race, ethnicity, body mass index (BMI), functional dependence, diabetes mellitus, smoking status, chronic obstructive pulmonary disease, steroid use, hypertension, congestive heart failure, and American Society of Anesthesiologists class. Comparative analyses were performed to evaluate the differences in demographic characteristics and comorbidities between the primary and revision surgery groups.

### Statistical analysis

Baseline characteristics and outcomes between the primary and revision cohorts were assessed using Chi-squared tests for categorical variables (e.g. sex, race, and smoking status) and *t*-tests for continuous variables (e.g. age and BMI). The factors independently associated with the occurrence of complications were identified using multivariable Poisson regression, adjusted for demographics and comorbidities that varied significantly with revision surgery. These factors included age, sex, race, BMI, diabetes, smoking, and hypertension. Statistical significance was defined as  $P < 0.05$ . All statistical analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) software version 29.0 (IBM, Armonk, NY, USA).

## RESULTS

A total of 37,669 patients were included, of whom 3635 (9.6%) required revision surgery. Patients in the revision cohort were older ( $54.25 \pm 15.7$  vs.  $50.85 \pm 16.0$  years,  $P < 0.001$ ) and had higher proportions of male (59.0% vs. 55.7%,  $P < 0.001$ ) and non-Hispanic White patients (82.0% vs. 77.4%,  $P < 0.001$ ). The baseline characteristics of each cohort are outlined in Table 1. The univariate analysis demonstrated a longer length of stay of  $1.58 \pm 2.7$  days in the revision cohort compared to  $1.11 \pm 2.5$  days in the primary cohort ( $P < 0.001$ ). Rates of wound infection (2.1% vs. 1.4%,  $P = 0.002$ ) and bleeding events requiring transfusion (1.3% vs. 0.7%,  $P < 0.001$ ) were higher among patients undergoing revision than in those who did not. The number of dural tear complications (0.11% vs. 0.044%,  $P = 0.092$ ) and cerebrospinal fluid leaks (0.25% vs. 1.14%,  $P = 0.116$ ) were greater in the revision cohort, approaching significance. The comparison of clinical outcomes and complications is outlined in Table 2.

**Table 1: Baseline characteristics of patients undergoing primary and revision discectomy from 2019 to 2022**

Characteristics	Primary discectomy, n (%)	Revision discectomy, n (%)
Number of cases	34,034	3635
Age (mean $\pm$ SD)	50.85 $\pm$ 16.0	54.25 $\pm$ 15.7
< 45	13,367 (39.3)	1129 (31.1)
45–54	6399 (18.8)	715 (19.7)
55–64	6395 (18.8)	720 (19.8)
$\geq 65$	7873 (23.1)	1071 (29.5)
Sex		
Male	18,951 (55.7)	2146 (59.0)
Female	15,035 (44.2)	1489 (41.0)
Race and ethnicity		
Non-Hispanic White	21,975 (77.4)	2534 (82.0)
Non-Hispanic Black	2154 (7.6)	218 (7.1)
Hispanic	2667 (9.4)	257 (8.3)
Asian	1072 (3.8)	68 (1.9)
BMI category		
< 25	6846 (20.1)	634 (17.4)
25–29	11,530 (33.9)	1201 (33.0)
30–34	8585 (25.2)	990 (27.2)
$\geq 35$	7019 (20.6)	803 (22.1)
Comorbidities		
Functional dependence	560 (1.6)	77 (2.1)
ASA class $\geq 3$	11,658 (34.3)	1529 (42.1)
Diabetes mellitus	4601 (13.5)	647 (17.8)
Smoker	6006 (17.6)	715 (19.7)
COPD	766 (2.3)	104 (2.9)
CHF	198 (0.6)	34 (0.9)
Hypertension	12,196 (35.8)	1164 (44.4)
Steroid use	1374 (4.0)	182 (5.0)

BMI - Body mass index; COPD - Chronic obstructive pulmonary disease;  
 ASA - American Society of Anesthesiologists; SD - Standard deviation;  
 CHF - Congestive heart failure

Multivariable Poisson log-linear regression demonstrated revision as a significant predictor of length of stay ( $\chi^2 = 462.95$ ,  $P < 0.001$ ), wound infection ( $\chi^2 = 9.22$ ,  $P = 0.002$ ), and bleeding events ( $\chi^2 = 9.74$ ,  $P = 0.002$ ) while approaching significance for cerebrospinal fluid leak ( $\chi^2 = 2.61$ ,  $P = 0.106$ ) and dural tear complication ( $\chi^2 = 2.37$ ,  $P = 0.123$ ). Age was a significant predictor for length of stay ( $\chi^2 = 2696.36$ ,  $P < 0.001$ ), bleeding events ( $\chi^2 = 132.77$ ,  $P < 0.001$ ), and dural tear complications ( $\chi^2 = 4.31$ ,  $P = 0.038$ ). Male sex predicted length of stay ( $\chi^2 = 469.63$ ,  $P < 0.001$ ) and wound infection ( $\chi^2 = 5.02$ ,  $P = 0.025$ ), while race predicted length of stay ( $\chi^2 = 3,819.88$ ,  $P < 0.001$ ), wound infection ( $\chi^2 = 24.06$ ,  $P < 0.001$ ), and bleeding events ( $\chi^2 = 251.83$ ,  $P < 0.001$ ). Comorbidities including diabetes ( $\chi^2 = 8.35$ ,  $P = 0.004$ ) and smoking ( $\chi^2 = 9.22$ ,  $P = 0.002$ ) were predictive of wound infection. Hypertension ( $\chi^2 = 29.22$ ,  $P < 0.001$ ), smoking ( $\chi^2 = 3.97$ ,  $P = 0.046$ ), and diabetes ( $\chi^2 = 255.97$ ,  $P < 0.001$ ) were also predictors of length of stay. The multivariable regression models are outlined in Table 3.

## DISCUSSION

Multiple studies have compared the outcomes of primary and revision discectomy, citing reoperation, readmission, length of stay, dural tear, and nervous injury as common complications in lumbar microdiscectomy. Two single-institutional studies conducted by Morgan-Hough *et al.* and Papadopoulos *et al.* reported higher rates of durotomy in revision compared to primary discectomy.<sup>[12,19]</sup> A retrospective analysis of data from the SPORT found no significant difference in length of stay, wound infection, durotomy, blood loss, wound infection, or neurological injury among revision patients.<sup>[20]</sup> However, a separate subgroup analysis conducted on the SPORT data by Leven *et al.* found higher rates of wound infection and longer length of stay in the revision discectomy cohort with no difference in other complications.<sup>[11]</sup> With no clear consensus on variations in complication rates in revision compared to primary lumbar microdiscectomy, we describe the length of stay, rates of wound infection, bleeding events, cerebrospinal fluid leak, durotomy, and neurological

**Table 2: Complications and clinical outcomes of patients undergoing primary and revision discectomy**

Characteristics	Primary discectomy, n (%)	Revision discectomy, n (%)	P (two-sided)
Length of stay	1.11 $\pm$ 2.5	1.58 $\pm$ 2.7	<0.001
Wound infection	487 (1.4)	76 (2.1)	0.002
Bleeding events requiring transfusion	241 (0.7)	46 (1.3)	<0.001
Cerebrospinal fluid leak	48 (0.1)	9 (0.2)	0.116
Dural tear complication	15 (<0.01)	4 (0.01)	0.092
Neurological injury	22 (<0.01)	3 (<0.01)	0.691

**Table 3: Multivariate regression model for primary versus revision discectomy as a predictor of complications and clinical outcomes**

Characteristics	Wald Chi-square	P
Length of stay		
Revision	462.95	<0.001
Age	2696.36	<0.001
Male sex	469.63	<0.001
Race	3819.88	<0.001
BMI	62.83	<0.001
Diabetes	255.97	<0.001
Smoking	3.97	0.046
Hypertension	29.22	<0.001
Wound infection		
Revision	9.22	0.002
Age	0.67	0.414
Male sex	5.02	0.025
Race	24.06	<0.001
BMI	40.32	<0.001
Diabetes	8.35	0.004
Smoking	9.22	0.002
Hypertension	0.563	0.453
Bleeding events requiring transfusion		
Revision	9.74	0.002
Age	132.77	<0.001
Male sex	2.69	0.101
Race	251.83	<0.001
BMI	1.31	0.253
Diabetes	0.140	0.708
Smoking	0.167	0.683
Hypertension	0.007	0.932
Cerebrospinal fluid leak		
Revision	2.61	0.106
Age	0.99	0.320
Male sex	0.233	0.629
Race	0.383	0.536
BMI	1.32	0.251
Diabetes	2.09	0.148
Smoking	0.499	0.480
Hypertension	0.144	0.705
Dural tear complication		
Revision	2.37	0.123
Age	4.31	0.038
Male sex	0.069	0.793
Race	0.096	0.757
BMI	3.62	0.057
Diabetes	0.25	0.619
Smoking	0.353	0.553
Hypertension	0.354	0.552
Neurological injury		
Revision	0.229	0.632
Age	2.143	0.143
Male sex	0.229	0.632
Race	0.002	0.967
BMI	0.201	0.654
Diabetes	0.616	0.433
Smoking	1.320	0.553
Hypertension	0.700	0.403

BMI - Body mass index

injury using the ACS-National Surgical Quality Improvement Program (NSQIP) database.

The univariate comparison between primary revision lumbar discectomy cohorts demonstrated a longer length of stay, a higher incidence of wound infection and bleeding events in the revision discectomy cohort, and a greater proportion of revision patients experiencing cerebrospinal fluid leak and durotomy, approaching significance. The multivariate regression model similarly demonstrated revision as a significant and independent predictor of length of stay, wound infection, and bleeding events. A study conducted by Phan *et al.* found no difference in reoperation, readmission, length of stay, or other complications in ACS-NSQIP from 2005 to 2012 in a propensity-matched cohort of 649 patients.<sup>[14]</sup> However, with NSQIP only introducing reoperation ICD-10 codes in 2012, this study did not include data looking at dural tear, neurological injury, or cerebrospinal fluid leaks. The findings from our analysis are in support of retrospective findings of the subgroup analysis of SPORT data by Leven *et al.* that found longer length of stay and more wound infections in revision discectomy patients.<sup>[11]</sup> However, we found the occurrence of bleeding events requiring transfusion to be greater in the revision cohort in contrast to the findings from analyses of the SPORT data that found no difference in blood loss.<sup>[11,20]</sup>

We additionally report higher rates of cerebrospinal fluid leak and dural tear complications in the revision discectomy report, approaching significance. Notably, the rates of both complications in our study hovered around 0.1%, significantly lower than previously reported rates, with two studies conducted by Morgan-Hough *et al.* and Papadopoulos *et al.* citing rates between 3.1% and 14.3%.<sup>[12,19]</sup> This can likely be attributed to inaccurate ICD-10 coding that was used to identify these complications, with many reoperation codes referring to unspecified complications, as well as reoperations occurring outside of the 30-day period included in NSQIP. With nearly double the rate of dural tear complications (0.11% vs. 0.04%) and cerebrospinal fluid leak (0.25% vs. 0.14%) in the revision cohort, it is possible that with accurate coding, this difference would be significant. With two institutional studies demonstrating greater rates of durotomy in revision discectomy patients and data from the SPORT demonstrating no such difference, these results from a national database add a new dimension to the literature.<sup>[11,12,19]</sup>

### Limitations

There are several limitations to consider in this study. The retrospective design of the study might introduce selection bias. CPT billing codes were used to generate the primary and revision discectomy patient cohorts, with ICD-10 used



to identify patients with cerebrospinal fluid leak, dural tear complications, and neurological injuries. These codes do not always accurately reflect the patient population, and ICD-10 codes are susceptible to inaccurate coding that likely underrepresents the occurrence of these complications. However, the methods adjusted for potential confounding variables by adjusting for covariates and excluding procedures involving cancer, preoperative sepsis, and nonlumbar regions of the spine.

## CONCLUSION

Revision lumbar microdiscectomy is associated with higher complication rates compared to primary discectomy patients, independent of baseline demographics and comorbidities. Linear regression demonstrated revision as a significant and independent predictor of increased length of stay, bleeding events, and wound infection while approaching significance for cerebrospinal fluid leaks and dural tear complications. Patients and surgeons alike should be aware of the increased risk of complications following revision discectomy.

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## Conflicts of interest

There are no conflicts of interest.

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