

Clinical Study

# Lumbar discectomy is associated with higher rates of lumbar fusion

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## Abstract

**BACKGROUND CONTEXT:** Lumbar disc herniation affects more than 3 million people in the United States every year, and the rate of operation continually increases, particularly in patients 60 years or older (Taylor et al., 1994; Jordan et al., 2011). Surgical discectomy is a common treatment for lumbar disc herniation (Taylor et al., 1994; Atlas et al., 1996). One concern for this method is the risk of undergoing additional surgeries (Jordan et al., 2011; Österman et al., 2003; Lebow et al., 2011). There are very limited population-level studies that examine the rate of lumbar fusion after lumbar discectomy. Additionally, there is no study that examines the risk of undergoing lumbar fusion in patients who have undergone lumbar discectomies compared with the risk of lumbar fusion in the general population with no previous lumbar discectomy.

**PURPOSE:** The present study aimed to calculate a more definitive rate of lumbar fusion after a lumbar discectomy procedure using a population-size study of more than 200,000 patients in the Truven Healthcare Analytics Marketscan Research Database who underwent discectomies. Additionally, the study aimed to compare the rate of lumbar fusion in patients who have undergone a lumbar discectomy to the rate of lumbar fusion in patients with no prior lumbar discectomy procedure.

**STUDY DESIGN/SETTING:** This is a retrospective cohort study.

**PATIENT SAMPLE:** The patients from both parts of the present study were extracted from the Truven Healthcare Analytics Marketscan Research Database.

*Ten-year fusion after discectomy rates:* 223,291 patients who underwent discectomies from the years 2003 to 2015.

*Fusion rate comparison:* 489,975 patients with a previous lumbar ICD-9 (International Classification of Diseases, Ninth Revision) diagnosis code who have also been enrolled in the database for at least 10 years.

**OUTCOME MEASURES:** *Ten-year fusion after discectomy rates:* The proportion of patients who received a lumbar fusion up to 10 years after a lumbar discectomy.

*Fusion rate comparison:* The proportion of patients who received a lumbar fusion after a lumbar discectomy compared with the proportion of patients who received a lumbar fusion with no previous lumbar discectomy.

**METHODS:** *Ten-year fusion after discectomy rates:* The patients who had undergone discectomies were filtered in the Marketscan database via Current Procedural Terminology (CPT) codes specific for lumbar discectomy (63030, 63035). Patients who had a lumbar fusion before or concurrently with these indexed lumbar discectomy dates were removed from the index group. The group was then followed up every year up to 10 years after the initial indexed lumbar discectomy dates for reoperation involving a lumbar spinal fusion according to the lumbar fusion CPT codes (22533, 22558, 22612, 22630, 22632, 22633, 22634, 22534, 22585, 22614).

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*Fusion rate comparison:* Study population only included patients who had a previous lumbar ICD-9 diagnosis in the Marketscan database (7242, 72210, 72251, 72252, 72273, 72293, 7213, 72142, 72283, 72293, 7243, 72402, 72403, 7244, 7245, 7249). The patients were then separated into two arms: one with patients who had undergone lumbar discectomy after initial lumbar diagnosis and another with patients who had not undergone a lumbar discectomy procedure. Pearson chi-square test was used to assess significance when comparing the proportion of patients who receive lumbar fusion after lumbar discectomy with the proportion of patients who receive lumbar fusion without a prior lumbar discectomy in the general ICD-9 lumbar diagnosis population.

**RESULTS:** For the 10-year trend of lumbar fusion rates after lumbar discectomy, the rate of fusion ranged from 1.69% (1-year time frame after discectomy) to 8.50% (10-year time frame after discectomy). When comparing the two cohorts in the second part of the present study, the fusion rates were 12.50% for the discectomy group and 4.19% for the non-discectomy group. The Pearson chi-square test reported a statistically significant difference between the fusion rates of the two groups ( $p < .0001$ ,  $\alpha = .05$ ). We found that people who had a lumbar discectomy procedure were 2.97 (95% confidence interval [2.86, 3.10]) times more likely to undergo a lumbar fusion than those who with a lumbar diagnosis but had not undergone a lumbar discectomy in the past.

**CONCLUSIONS:** Our study is the largest population study that explores the rate of lumbar fusion after an initial lumbar discectomy. To our knowledge, it is the first study that concludes that an initial lumbar discectomy is statistically associated with an increased likelihood of a patient undergoing a lumbar fusion in the future. We observed that patients who had previously undergone a lumbar discectomy were roughly three times more likely to undergo a lumbar fusion procedure than a patient with a lumbar diagnosis, but had not undergone a lumbar discectomy. Although not calculated, it stands to reason the difference would be even greater when comparing the discectomy population with a population without lumbar diagnoses. This finding can be an important supplement for the physician-patient discussion regarding expectations and potential for reoperation. © 2018 Elsevier Inc. All rights reserved.

*Keywords:*

Arthrodesis; Artificial ankylosis; Disc herniation; Fusion rate; Lumbar discectomy; Syndesis

## Introduction

Lumbar disc herniation affects more than 3 million people in the United States every year, and the rate of operation continually increases, particularly in patients 60 years or older [1,2]. Surgical discectomy is a common treatment for lumbar disc herniation [1,3]. Importantly, previous studies have highlighted the benefits of undergoing a surgical discectomy versus medical interventional treatment for lumbar disc herniation [2,4].

Some studies have suggested a trend toward reoperation after a lumbar discectomy procedure [2,5,6]. However, all have different estimates of this trend [5,7]. Some potential reasons for the discrepancies between these studies are a smaller number of subjects or patient demographics [5,7,8]. There are very limited population-level studies that examine the rate of lumbar fusion after lumbar discectomy. Additionally, there is no study that examines the risk of undergoing lumbar fusion in patients who have undergone lumbar discectomies compared with the risk of lumbar fusion in the general population with no previous lumbar discectomy.

The purpose of the present study was to calculate a more definitive rate of lumbar fusion after a lumbar discectomy procedure using a population-size study of more than 200,000 patients in the Truven Healthcare Analytics Marketscan Research Database who underwent discectomies. We hypothesize that the rate of lumbar fusion increases in patients who have undergone a lumbar discectomy compared with patients with no prior lumbar discectomy procedure.

## Methods

### Data source

The data for our study were extracted from the Truven Healthcare Analytics Marketscan Research Database (Marketscan). Marketscan fully integrates all aspects of healthcare for individual patients and allows for analysis of longitudinal records including, but not limited to, their inpatient, outpatient, drug, and laboratory insurance claims from the years 2003 to 2015. These claims are obtained from commercial insurance, supplemental Medicare, and Medicaid, reflecting a large population all over the United States. These data are collected from employers, health plans, and state Medicaid agencies who have agreed to be data contributors. A unique identifier is assigned to each individual within the database to encrypt information but at the same time allow for longitudinal follow-up of individual patients. The database currently holds more than 32 billion service records, with nearly 240 million patients enrolled in the system.

The Marketscan database has been used in many large population studies in the past [8–15]. To generate patient claims in Marketscan, International Classification of Diseases, Ninth Revision (ICD-9) and Current Procedural Terminology (CPT) codes were used. Some shortcomings of Marketscan, like many databases, is that a large convenience sample is used and may not generalize well to other populations. Additionally, Marketscan data are confined to procedural codes and therefore

Table 1  
Ten-year lumbar fusion rates

Time (years after initial lumbar discectomy)	Discectomies	Fusions	Fusion rate (%)
1	223,291	3,773	1.69
2	146,141	4,325	2.96
3	98,467	3,922	3.98
4	68,305	3,398	4.97
5	47,175	2,806	5.95
6	33,386	2,226	6.67
7	23,490	1,752	7.46
8	16,522	1,324	8.01
9	11,468	942	8.21
10	7,270	618	8.50

would not be granular enough to establish causative links as a standalone source.

The patient data are completely de-identified and HIPAA compliant. The present study was granted an exemption by the University of Chicago Institutional Review Board.

#### Selection criteria

##### Ten-year fusion after discectomy rates

The first part of the present study reports the fusion rates after a discectomy for a variable number of years (Table 1). First, Marketscan was filtered for all of the patients who had undergone a lumbar discectomy and were billed the according lumbar discectomy CPT codes (63030, 63035). Patients who had a lumbar fusion before or concurrently with these indexed lumbar discectomy dates were removed from the index group. The group was then followed up every year up to 10 years after the initial indexed lumbar discectomy dates for reoperation involving a lumbar spinal fusion according to the lumbar fusion CPT codes (22533, 22558, 22612, 22630, 22632, 22633, 22634, 22534, 22585, 22614). Patients who did not have continuous enrollment through the number of years in question (1–10) were excluded from the indexed group to eliminate patients who left the database after initial lumbar discectomy. For example, if we were interested in looking at the lumbar fusions 1 year after discectomy, we would first make sure the patients with lumbar discectomies were continuously enrolled for 1 year. This continuous enrollment criterion decreased the number of our patients with lumbar discectomies as we included more years (Table 1). A rate was then calculated from the total number of patients that underwent a lumbar fusion out of the total number of patients who underwent an initial lumbar discectomy for each of the time spans.

##### Fusion rate comparison

The second part of the present study was a retrospective cohort analysis that focused on comparing the risks of undergoing lumbar fusion after a lumbar discectomy with the risk of undergoing lumbar fusion with no previous lumbar discectomy. To eliminate confounding variables, our study population only included patients who had a previous lumbar

ICD-9 diagnosis. The starting population to draw this comparison was filtered from the general database by searching for all of the patients who had a previous lumbar ICD-9 diagnosis code (7242, 72210, 72251, 72252, 72273, 72293, 7213, 72142, 72283, 72293, 7243, 72402, 72403, 7244, 7245, 7249). These diagnosis codes encompassed all lumbar diagnoses that can be billed including such conditions as lumbago, lumbar spondylosis, and radiculopathy. Only patients who were continuously enrolled for at least 10 years after the indexed date for the initial lumbar ICD-9 diagnosis were included from the indexed population.

The patients were then separated into two arms: one with patients who had undergone lumbar discectomy after initial lumbar diagnosis and another with patients who had not undergone a lumbar discectomy procedure. This discectomy cohort was obtained using the billing of lumbar discectomy CPT codes (63030, 63035). The non-discectomy cohort was obtained by removing the patients who were billed for the same lumbar discectomy CPT codes (63030, 63035). Patients who had undergone lumbar fusion were then queried from each of these two groups (with lumbar fusion occurring after the lumbar discectomy in the discectomy arm). This final step was collected using the lumbar fusion CPT codes (22533, 22558, 22612, 22630, 22632, 22633, 22634, 22534, 22585, 22614).

#### Statistical analysis

The two arms of the retrospective cohort study were the discectomy and non-discectomy groups, with exposure being defined as lumbar discectomy. The final outcome was a binomial variable that was measured by either receiving lumbar fusion or not receiving lumbar fusion. Pearson chi-square test was used to assess significance when comparing the proportion of patients who receive lumbar fusion after lumbar discectomy with the proportion of patients who receive lumbar fusion without a prior lumbar discectomy in the general ICD-9 lumbar diagnosis population. Results were considered significant at  $p < .05$ . Relative risk and odds ratio were also calculated. All statistical analyses were performed with IBM SPSS Statistics 24 (Armonk, NY, USA).

#### Results

For the 10-year trend of lumbar fusion rates after lumbar discectomy, more than 500,000 patients who underwent a lumbar discectomy (CPT 63030, 63035) between 2003 and 2015 were extracted from the Marketscan database. Patients who were not continuously enrolled in Marketscan for the different time spans (between 1 and 10 years) were removed because it was not possible to completely follow them after initial lumbar discectomy (Fig. 1). We then generated the number of lumbar fusions out of our discectomy population over our several selected time spans. The rates of lumbar fusion gradually increased each additional year after the initial

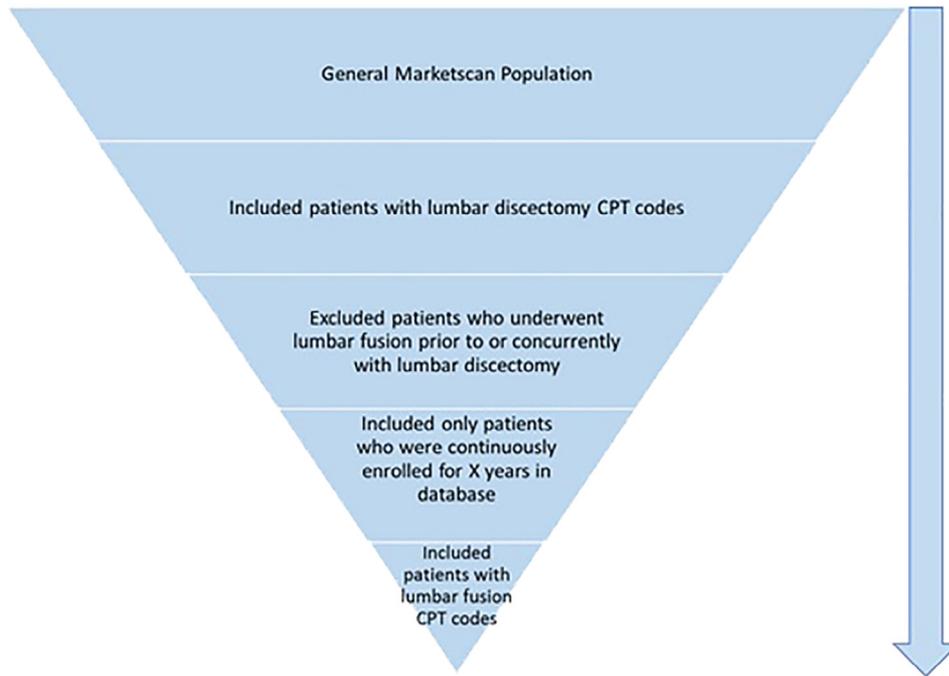


Fig. 1. Ten-year lumbar fusion after lumbar discectomy data extraction steps. X is the number of years that we are interested in following a patient after initial lumbar discectomy. CPT, Current Procedural Terminology.

lumbar discectomy procedure for up to 10 years (Tables 1 and 2).

When assessing the risk of lumbar fusion after lumbar discectomy in the retrospective cohort portion of the present study, over a million patients were found to have an ICD-9 lumbar diagnosis for at least one lumbar diagnosis from 2003 to 2015. This number of patients decreased to 489,795 after applying our continuous enrollment criteria of 10 years. This indexed population was then divided into two cohorts: a lumbar discectomy group with 18,890 patients who received a lumbar discectomy after the initial lumbar diagnosis and a non-discectomy group composed of 470,905 patients who did not undergo a lumbar discectomy after the initial lumbar diagnosis (Fig. 2). For the first treatment arm with 18,890 patients who received a lumbar discectomy, 2,355 went on to have a lumbar fusion procedure. In the second treatment arm with 470,905 patients who did not undergo a lumbar discectomy, 19,742 nevertheless received a lumbar fusion (Table 3).

When comparing the two cohorts, the fusion rates were 12.50% for the discectomy group and 4.19% for the non-

discectomy group. The Pearson chi-square test reported a statistically significant difference between the fusion rates of the two groups ( $p < .0001$ ,  $\alpha = .05$ ). We found that people who had a lumbar discectomy procedure were 2.97 (95% confidence interval [2.86, 3.10]) times more likely to undergo a lumbar fusion than those who with a lumbar diagnosis but had not undergone a lumbar discectomy in the past (Table 4).

**Discussion**

The present study highlights the significantly increased risk of having a lumbar fusion after a lumbar discectomy, compared with the risk in patients with lumbar diagnoses but

Table 2  
Population ages

Age at lumbar ICD-9 diagnosis	Number of patients
<19	15,171
20–39	84,498
40–59	267,929
60–79	108,592
80+	13,606

ICD-9, International Classification of Diseases, Ninth Revision.

Table 3  
Lumbar fusion reoperation contingency table

	Fusion	No fusion	Column totals
Discectomy	2,355	16,535	18,890
No discectomy	19,742	451,163	470,905
Row totals	467,698	22,097	489,795

Table 4  
Retrospective cohort statistical analysis

	Value	.95 Confidence intervals	
		Lower limit	Upper limit
Risk ratio	2.97	2.86	3.10
Odds ratio	3.25	3.11	3.41
Pearson	2886.49		
p-Value	<.0001		

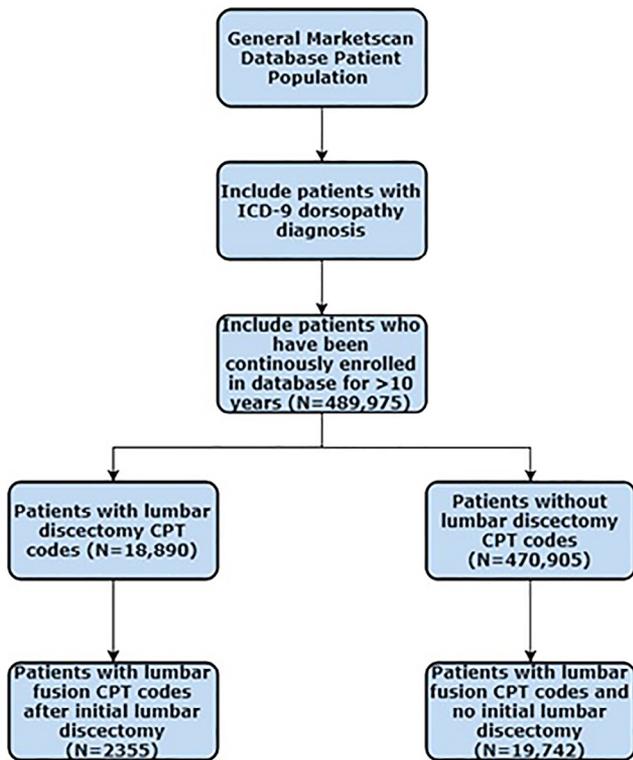


Fig. 2. Retrospective cohort database extraction methodology. CPT, Current Procedural Terminology; ICD-9, International Classification of Diseases, Ninth Revision.

without a previous history of lumbar discectomy. In addition to raising surgeon awareness and understanding, these data can enable surgeons to counsel patients on the likelihood of fusion in a 10-year period after lumbar discectomy.

Two previous studies reported the rate of lumbar fusion after initial lumbar discectomy. Österman et al. [5] reported a rate of 2.8% in a population of 35,309 patients in the Finnish Hospital Discharge Register over the time span of 11 years who underwent an initial lumbar discectomy. Moreover,

Heindel et al. [7] reported a lumbar fusion rate of 5.9% four years after initial lumbar discectomy within 13,654 patients in the Humana database. In contrast, we found a 4.97% rate of fusion 4 years after initial lumbar discectomy within a population of 68,305 patients from the Truven Healthcare Analytics Marketscan Research Database (Marketscan). Some potential reasons for these discrepancies are the variety of care from our sample in terms of diversity (compared with the Finnish Hospital Discharge Register) and of different insurers (compared with the Humana database), as well as our increased sample size. Additionally, we reported the trend of lumbar fusion rates from 1 to 10 years after the initial lumbar discectomy (Fig. 3). These additional years and our large population sample display a broader demonstration of lumbar fusion reoperations in the United States.

To our knowledge, there is no current study that compares the rate of lumbar fusion after a lumbar discectomy with the rate of lumbar fusion with no previous lumbar discectomy. We observed that there is a statistically significantly associated risk of lumbar fusion after a patient has undergone a lumbar discectomy ( $p < .0001$ ). In particular, patients were 2.97 times more likely to undergo lumbar fusion if they had previously undergone a lumbar discectomy than patients who did not receive a lumbar discectomy.

Some limitations of the database include the fact that Marketscan incorporates commercial insurance, Medicare supplemental, and Medicaid claims. This may deviate from a complete representation of the United States because of the variety of insurances that the population holds, including the uninsured. However, we sought to minimize these limitations by using an inclusion criterion that ensured that patients were continuously enrolled during the duration of the present study. Another limitation of the study design, as with any other study relying solely on ICD-9 and CPT codes, is that there is uncertainty of exactly what vertebral level of the lumbar spine was operated on by the providers. Some patients may be receiving lumbar fusions in a different vertebra than where they received their initial lumbar discectomies. Although this

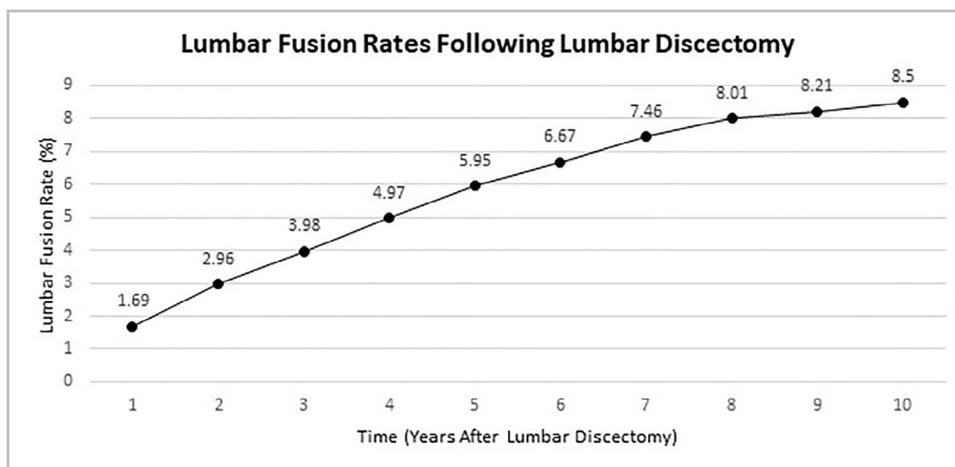


Fig. 3. Ten-year trend of lumbar fusion rate after lumbar discectomy.

seems unlikely, it is a possibility that cannot be accounted for within this analysis. Finally, the present study is not granular enough to sub-analyze the indications for fusion after discectomy: postdiscectomy spondylolisthesis, recurrent disc herniation, or discogenic back pain. Surgeon-specific thresholds for proceeding to fusion may be dependent on surgeon-specific philosophies of fusion indication.

Despite the limitations, our study is the largest population study that explores the rate of lumbar fusion after an initial lumbar discectomy. To our knowledge, it is the first study that concludes that an initial lumbar discectomy is statistically associated with an increased likelihood of a patient undergoing a lumbar fusion in the future. A future cohort study with access to complete patient records would be ideal to establish a causative link between lumbar discectomy and lumbar fusion. We observed that patients who had previously undergone a lumbar discectomy were roughly three times more likely to undergo a lumbar fusion procedure than a patient with a lumbar diagnosis, but had not undergone a lumbar discectomy. Although not calculated, it stands to reason the difference would be even greater when comparing the discectomy population with a population without lumbar diagnoses. These findings can be useful to practicing surgeons when counseling patients who are recommended to have microdiscectomy surgery.

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