Incidence of Low Back Pain After Lumbar Discectomy for Herniated Disc and Its Effect on Patient-reported Outcomes

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Abstract

Background Long-term postdiscectomy degenerative disc disease and low back pain is a well-recognized disorder; however, its patient-centered characterization and quantification are lacking.

Questions/purposes We performed a systematic literature review and prospective longitudinal study to determine the frequency of recurrent back pain after discectomy and quantify its effect on patient-reported outcomes (PROs).

Methods A MEDLINE search was performed to identify studies reporting on the frequency of recurrent back pain, same-level recurrent disc herniation, and reoperation after primary lumbar discectomy. After excluding studies that did not report the percentage of patients with persistent

back or leg pain more than 6 months after discectomy or did not report the rate of same level recurrent herniation, 90 studies, which in aggregate had evaluated 21,180 patients, were included in the systematic review portion of this study. For the longitudinal study, all patients undergoing primary lumbar discectomy between October 2010 and March 2013 were enrolled into our prospective spine registry. One hundred fifteen patients were more than 12 months out from surgery, 103 (90%) of whom were available for 1-year outcomes assessment. PROs were prospectively assessed at baseline, 3 months, 1 year, and 2 years. The threshold of deterioration used to classify recurrent back pain was the minimum clinically important difference in back pain (Numeric Rating Scale Back Pain [NRS-BP]) or Disability (Oswestry Disability Index [ODI]), which were 2.5 of 10 points and 20 of 100 points, respectively.

Results Systematic Review The proportion of patients reporting short-term (6–24 months) and long-term (> 24 months) recurrent back pain ranged from 3% to 34% and 5% to 36%, respectively. The 2-year incidence of recurrent disc herniation ranged from 0% to 23% and the frequency of reoperation ranged from 0% to 13%.

Prospective Study At 1-year and 2-year followup, 22% and 26% patients reported worsening of low back pain (NRS: 5.3 ± 2.5 versus 2.7 ± 2.8 , $p < 0.001$) or disability (ODI%: 32 ± 18 versus 21 ± 18 , $p < 0.001$) compared with 3 months.

Conclusions In a systematic literature review and prospective outcomes study, the frequency of same-level disc herniation requiring reoperation was 6%. Two-year recurrent low back pain may occur in 15% to 25% of patients depending on the level of recurrent pain considered clinically important, and this leads to worse PROs at 1 and 2 years postoperatively.

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Introduction

The most common procedure performed in the United States for patients experiencing back and leg pain is lumbar discectomy [5, 10]. In 2003, 2.1 per 1000 Medicare enrollees received a lumbar discectomy/laminectomy [92]. Although the procedure has been performed for decades, the reported proportion of postsurgical degenerative disc disease and recurrent back and leg pain in the literature has been highly variable, ranging from as low as 3% to as high as 43% [42, 75].

A common challenge for spine surgeons after lumbar discectomy is reherniation at the same level. There is a wide variation of reported reherniation rates in the literature and it is unclear how many patients with reherniation undergo reoperation such as revision discectomy or instrumented fusion. There is great interest in the topic of reherniation after discectomy because it is associated with high cost and poor outcome (recurrent back pain, recurrent disc herniation, or reoperation) [65].

Surgeons have attempted more aggressive discectomies to try to reduce the incidence of reherniation, but this approach has been associated with greater postoperative degeneration and back pain [57]. Sequestrectomies of disc fragments have also been adopted to minimize disc removal and subsequent degenerative back pain but have been associated with greater reherniation [57]. Long-term postdiscectomy degeneration and back pain remains a recognized pathology. However, its patient-centered characterization and quantification are lacking.

The aims of this article are twofold. First, through a systematic literature review, we aimed to determine (1) the proportion of patients with short-term (6 months to 2 years postoperatively) and long-term (> 2 years postoperatively) postdiscectomy recurrent back pain; and (2) the frequency of same-level recurrent disc herniation and reoperation for first-time single-level lumbar discectomy. Second, through the use of our prospective longitudinal spinal outcomes registry, we sought to determine the (1) proportion of patients with recurrent degenerative back pain; and (2) quantify its effect on patients' pain, disability, and quality of life.

Materials and Methods

Literature Review

We performed a literature review to identify all published articles that reported outcomes after discectomy for primary lumbar disc herniation. Because much of the current techniques that are used today were popularized in the late 1970s and early 1980s by Williams and Spengler, we

limited our search to studies published after the introduction of their techniques (1980 to the present) [81, 96].

To answer the stated questions, search terms were identified and combined with appropriate Boolean connectors, and a search was carried out for English language publications on MEDLINE (PubMed). The search sequence submitted was the following: ("discectomy"[MeSH] OR discectomy[title] OR discectomy[title]) AND ("lumbosacral region" [MeSH Terms] OR lumbar[Title] OR "lumbar vertebrae"[MeSH terms]) AND ("Treatment Outcome"[MeSH] OR "Outcome Assessment (Health Care)"[MeSH] OR (outcome[All Fields] OR surgical outcomes[All Fields])). Limits were English language and publication date between 1980 and 2013.

All titles that resulted from these search criteria were reviewed. Case reports, technical notes, and animal or laboratory studies were not included in the study. Abstracts were then reviewed for all remaining studies. Abstracts on discectomy cohorts that included fusion procedures, patients undergoing revision discectomy, pediatric or elderly patients (age > 70 years), or other concurrent spinal pathologies were excluded. The remaining manuscripts were reviewed in their entirety. Only studies that assessed the incidence of recurrent or persistent symptoms more than 6 months after surgery or described the incidence of recurrent herniation were included for analysis.

For this systematic review, the primary endpoint assessed from each study was the persistent or recurrent back and leg pain that was reported to be clinically relevant to the patient or treating physician. However, this endpoint was not reported in a standardized fashion throughout the included studies. The majority of the studies reported the proportion of patients with persistent back and leg pain as fair to poor or moderate to poor outcome per the scales of Macnab [51], Prolo et al. [69], and Stauffer and Coventry [83]. The remaining studies plainly stated the incidence of persistent back or leg pain at the time of last patient followup evaluation. Despite the variation in reporting outcomes measures, each scale used persistent symptomatology to stratify outcome scores, making the categorical deduction of our endpoint possible. The incidence of recurrent or persistent back pain or leg pain, same-level recurrent disc herniation, and frequency of reoperation for recurrent disc herniation was recorded from each study.

Literature Search

The literature search yielded 1172 published studies. After reviewing the titles of these 1172 studies, 327 abstracts were identified that involved lumbar discectomy for

primary lumbar disc herniation and were reviewed. This identified 179 studies reporting more than 6-month outcomes of at least one discectomy cohort. The articles of these 179 studies were reviewed in their entirety. After excluding studies that did not report the percentage of patients with persistent back or leg pain more than 6 months after discectomy or did not report the rate of same-level recurrent herniation, 90 studies were included for analysis. A total of 21,180 patients were available for analysis in this study.

Prospective Study

Patient Selection

All patients undergoing discectomy for a lumbar herniated disc were enrolled into our institution's prospective spinal outcomes registry over a 3-year period (2010–2013). All patients had (1) radicular leg pain; (2) intervertebral disc herniation seen on MRI corresponding to radicular level; (3) age 18 to 70 years; and (4) failure of at least 6 weeks of medical management, which included physical therapy, epidural injections, antiinflammatory medications, and opioid analgesics. Patients were excluded if they had an extraspinal cause of back/neck pain or radiculopathy, an active medical or workmen's compensation lawsuit, or were unwilling or unable to participate with followup procedures. Only patients with 1 year or more of clinical outcomes postoperatively were included in the study. During the study period (October 2010 to March 2013), a total of 192 patients underwent discectomy for lumbar disc herniation and radicular leg pain at our institution. One hundred fifteen patients were more than 12 months from surgery, and 103 (90%) of them were available for 1-year outcomes assessment. Of these 115 patients, nine were lost to followup (7.8%) and three (2.6%) did not meet our inclusion criteria for the study. Thirty-five patients had passed 24 months from surgery, 30 (85%) of whom were available for 2-year outcomes assessment.

Clinical Outcomes Measures

Patient demographics, disease characteristics, treatment variables, readmissions/reoperations, and all 90-day surgical morbidity were assessed prospectively for each case and entered into a web-based portal (REDCap). Baseline, 3-month, 1-year, and 2-year postoperative pain, disability, and quality of life were prospectively accessed by phone interview by an independent technician (SKM) not involved with clinical care. Patient-reported outcome instruments (PROi) included the Numeric Rating Scale

(NRS) for low back pain and leg pain [30, 35], Oswestry Disability Index (ODI) [25], ED-5D [24], SF-12 physical component summary (PCS), and SF-12 mental component summary (MCS) [90].

Measure of Recurrent Back Pain and Disability

Patients were considered to have achieved treatment response after surgery at 3-months followup. Patients with 1-year and 2-years followup were examined to identify those who had subsequent deterioration as compared with their 3-month levels. The threshold of deterioration used to classify recurrent or delayed onset of new low back dysfunction was the minimum clinically important difference (MCID) values for ODI, NRS-back pain, and NRS-leg pain as described by Solberg et al. [80]. Cutoff values for a clinically meaningful decline in patient health and back/leg pain were change scores between the 3-month postoperative score and the 1-year or 2-year score of at least 20% (ODI) and 2.5 (NRS back) and 3.5 (NRS leg on a scale of 0–10) [80]. Any patient with a change score from 3-month to 1-year followup or from 3-month to 2-year followup that represented a decline greater than MCID thresholds in any one of these outcomes measures was considered to have developed postdiscectomy onset of low back pain and dysfunction.

Statistical Analysis

Parametric data were given as mean $\pm$ SD and compared by Student's t-test. Nonparametric data were given as median (interquartile range) and compared by Mann-Whitney U-test. Nominal data were compared with the chi square test. Probability values < 0.05 were considered statistically significant.

Results

Systematic Review

Short-term and Long-term Outcomes (recurrent back/leg pain)

Short-term outcome (6–24 months) after discectomy was reported in 39 discectomy cohorts ($n = 8156$). Among the included studies, the proportion of patients reporting recurrent back or leg pain ranged from 3% to 34% (Table 1).

Long-term outcome (> 24 months) after discectomy was reported in 28 discectomy cohorts ($n = 6255$). Among the included studies, the proportion of patients reporting

Table 1. Summary of short-term outcome (6 months to 2 years postoperatively), long-term outcome (> 2 years postoperatively), incidence of recurrent herniation, and rate of reoperation (fusion and/or discectomy)

Discectomy series	Number of patients	Short-term persistent back or leg pain (%)	Long-term persistent back or leg pain (%)	Recurrent herniation (%)	Rate of reoperation (%)	Number of fusions for revision	Number of discectomies for revision	Prospective versus retrospective study	Level of evidence I-V
Carragee et al. [13], 2006	76	11	—	14	9.2	1	6	Prospective	IIb
Caspar et al. [15], 1991	498	24	—	3.8	3.8	0	19	Retrospective	IIb
Chatterjee et al. [17], 1995	40	20	—	—	—	—	—	Prospective	Ib
Daneyemez et al. [19], 1999	1070	9	—	2.8	2.8	0	30	Retrospective	IV
Ejeskar et al. [23], 1983	14	7	—	—	—	—	—	Prospective	IIb
Findlay et al. [28], 1998	79	9	16	6.3	6.3	0	5	Retrospective	IV
Gorgulu et al. [34], 2004	99	22	—	2	2	0	2	Prospective	IIb
Kahanovitz et al. [42], 1989	64	34	—	1.6	1.6	—	—	Retrospective	IIb
Lowell et al. [48], 1995	100	11	—	3	1	0	1	Retrospective	IV
MacKay et al. [50], 1995	154	17	—	—	—	—	—	Prospective	IIb
Maroon and Ablu [54], 1985	50	10	—	2	2	0	1	Retrospective	IIb
Pappas et al. [64], 1992	654	19	—	4.6	4.6	0	30	Retrospective	IV
Quigley et al. [70], 1998	322	26	—	—	—	—	—	Prospective	IV
Rogers [71], 1988	68	19	—	10	—	—	—	Retrospective	IIb
Sachdev [74], 1986	300	6	—	—	—	—	—	Retrospective	IV
Silvers [79], 1988	270	8	—	7.4	7.4	0	20	Retrospective	IIb
Spengler [81], 1982	54	16	—	—	—	—	—	Retrospective	IV
Stambough [82], 1997	175	9	—	4.0	4.0	0	7	Retrospective	IV
Striffeler et al. [84], 1991	112	18	—	—	—	—	—	Retrospective	IIb
Thome et al. [85], 2005	84	22	—	7.1	7.1	0	6	Prospective	IIb
Tullberg et al. [86], 1993	60	15	—	3.3	3.3	0	2	Prospective	Ib
Tureyen [87], 2003	114	11	—	2	—	—	—	Prospective	IIb
Weber [91], 1983	76	13	—	—	—	—	—	Prospective	Ib
Weber [91], 1983	57	—	20	—	—	—	—	Prospective	Ib
Williams [97], 1986	903	9	14	4.2	4.2	0	38	Retrospective	IV
Kim et al. [43], 2007	902	15	—	6.7	4.4	0	40	Retrospective	IIb
Barth et al. [11], 2008	78	21	—	23	—	—	—	Prospective	Ib
Ruettan et al. [72], 2008	178	18	—	6.2	6.2	0	11	Prospective	Ib
Ambrossi et al. [3], 2009	141	12	—	12	7.8	0	11	Retrospective	IV
Acharya et al. [1], 2008	259	3	—	3.1	3.1	0	8	Retrospective	IIb
Salame and Lidar [75], 2010	31	3	—	—	—	—	—	Retrospective	IV
Fakouri et al. [26], 2011	101	8	—	5	5	0	5	Retrospective	IIb
Lau et al. [45], 2011	45	27	—	6.7	—	—	—	Retrospective	IIb

Table 1. continued

Discectomy series	Number of patients	Short-term persistent back or leg pain (%)	Long-term persistent back or leg pain (%)	Recurrent herniation (%)	Rate of reoperation (%)	Number of fusions for revision	Number of discectomies for revision	Prospective versus retrospective study	Level of evidence I-V
Amoretti et al. [4], 2012	100	18	—	—	—	—	—	Prospective	IV
Garg et al. [31], 2011	55	4	—	1.8	1.8	0	1	Prospective	Ib
Lonne et al. [46], 2012	91	20	—	—	—	—	—	Prospective	IIb
Ahsan et al. [2], 2012	398	15	15	0	0	0	0	Retrospective	IIb
Hermanin et al. [38], 1999	30	7	—	—	—	—	—	Prospective	Ib
Jensen et al. [41], 1996	99	17	—	—	—	—	—	Prospective	Ib
Asch et al. [8], 2002	212	23	—	13	10.8	13	10	Prospective	IV
Carragee et al. [12], 2003	180	—	12	8.9	6.1	3	8	Prospective	IV
Davis [20], 1994	984	—	11	6.1	6.1	7	53	Retrospective	IV
Fountas et al. [29], 2004	106	—	14	7.5	6.6	0	7	Prospective	IV
Goald [33], 1980	477	—	9	—	—	—	—	Retrospective	IV
Henriksen et al. [37], 1996	79	—	9	12.7	—	—	—	Prospective	IIb
Hirabayashi et al. [39], 1993	214	—	27	4.2	4.2	0	9	Retrospective	IV
Kowalski et al. [44], 1995	89	—	19	8	8	6	1	Retrospective	IIb
Loupasis et al. [47], 1999	101	—	36	3	3	0	3	Retrospective	IV
Mariconda et al. [53], 2006	201	—	28	—	—	—	—	Retrospective	IV
Moore et al. [60], 1994	100	—	7	8	8	0	8	Prospective	IV
Padua et al. [63], 1999	120	—	13	—	—	—	—	Retrospective	IV
Schoeggel et al. [76], 2002	258	—	9	9.7	—	—	—	Retrospective	IV
Schoeggel et al. [77], 2003	672	—	9	5.1	5.1	0	34	Retrospective	IV
Wenger et al. [94], 2001	104	—	7	5.8	5.8	2	4	Retrospective	IV
Yorimitsu et al. [98], 2001	72	—	13	12.5	12.5	0	9	Retrospective	IV
Chang et al. [16], 2009	24	—	8	12.5	8.3	0	2	Retrospective	IV
Parker et al. [66], 2010	111	—	32	—	—	—	—	Retrospective	IV
Silverplats et al. [78], 2010	140	—	23	—	—	—	—	Prospective	IV
Bakhsh [9], 2010	68	—	15	—	—	—	—	Retrospective	IV
Marquardt et al. [55], 2012	87	—	22	8.0	8.0	0	7	Retrospective	IV
Chumnanvej et al. [18], 2011	60	—	8	3.3	3.3	0	2	Prospective	IV
Lubbers et al. [49], 2012	22	—	9	9.1	9.1	0	2	Retrospective	IV
Wang et al. [89], 2012	151	—	5	3.3	3.3	0	5	Retrospective	IV
Ahsan et al. [2], 2012	398	—	15	0	0	0	0	Retrospective	IIb
Andrews and Lavayne [5], 1990	112	—	—	8	8	0	9	Retrospective	IIb
Balderston et al. [10], 1991	83	—	—	4.8	—	—	—	Retrospective	IIb
Faulhaber and Manicke [27], 1995	200	—	—	4.5	4.5	1	8	Retrospective	IIb

Table 1. continued

Discectomy series	Number of patients	Short-term persistent back or leg pain (%)	Long-term persistent back or leg pain (%)	Recurrent herniation (%)	Rate of reoperation (%)	Number of fusions for revision	Number of discectomies for revision	Prospective versus retrospective study	Level of evidence I-V
Gaston and Marshall [32], 2003	993	—	—	7.9	4.9	0	49	Retrospective	IV
Muralikuttan et al. [61], 1992	46	—	—	2.2	2.2	0	1	Prospective	Ib
Weinstein et al. [93], 2006	528	—	—	8.9	8.9	0	47	Prospective	IIIb
Wera et al. [95], 2008	1320	—	—	1.8	1.8	0	24	Retrospective	IV
Williams [97], 1986	200	—	—	5	5	0	10	Retrospective	IV
Jensdottir et al. [40], 2007	134	—	—	12.7	12.7	0	17	Retrospective	IV
Guilfoyle et al. [36], 2007	203	—	—	5.4	5.4	0	11	Prospective	IV
Dewing et al. [22], 2008	183	—	—	3.3	2.2	2	2	Prospective	IV
Wera et al. [95], 2008	1320	—	—	1.1	1.1	2	12	Retrospective	IIIb
Ryang et al. [73], 2008	60	—	—	10	10	0	6	Prospective	Ib
Mariconda et al. [52], 2008	180	—	—	15.6	—	—	—	Retrospective	IV
Peng et al. [67], 2009	55	—	—	11	9.1	3	2	Retrospective	IV
Arts et al. [6], 2009	325	—	—	6.2	6.2	0	20	Prospective	Ib
McGirt et al. [58], 2009	108	—	—	22.2	10.1	0	11	Prospective	IIb
Peng et al. [68], 2010	55	—	—	5.5	3.6	0	2	Prospective	IV
Fakouri et al. [26], 2011	96	—	—	5.2	5.2	0	5	Retrospective	IIb
Okoro and Sell [62], 2010	130	—	—	3.8	3.8	0	5	Prospective	IIb
Veresciagina et al. [88], 2010	100	—	—	9	—	—	—	Prospective	IIb
Molitemo et al. [59], 2010	147	—	—	9.5	9.5	0	14	Retrospective	IV
Casal-Moro et al. [14], 2011	120	—	—	1.7	1.7	0	2	Prospective	IV
Arts et al. [7], 2011	325	—	—	7.7	7.7	0	25	Prospective	Ib
Desai et al. [21], 2012	782	—	—	2.7	2.7	0	21	Prospective	IIb
Matsumoto et al. [56], 2013	344	—	—	10.8	6.4	0	22	Retrospective	IV
Range	3–34	5–36	0–23	0–23	0–12.7				
Cumulative incidence	21180	14.2	13.9	5.3	4.4	40	732		

recurrent back or leg pain ranged from 5% to 36% (Table 1). Levels of evidence on the endpoint of short- and long-term low-back pain ranged from Ib to IV (Table 1).

Recurrent Disc Herniation and Reoperation

The incidence of recurrent disc herniation was reported in 70 studies ($n = 18,085$). Among the included studies, the incidence of same-level recurrent disc herniation ranged from 0% to 23% with 61 studies reporting a reoperation rate (Table 1). The revision procedure was fusion in 5% and revision discectomy in 95% of the cases. Levels of evidence on the endpoint of recurrent herniation and reoperation ranged from Ib to IV (Table 1).

Prospective Cohort Study

Surgical Treatment and Complications

The baseline characteristics of prospective cohort are described (Table 2). The mean length of surgery was 90.42 ± 34.18 minutes with an average blood loss of 86.17 ± 117.13 mL and a median (interquartile range) hospital stay of 1 (1–2) day. Postoperative complications occurred in a total of seven (7%) patients and included wound hematoma, wound infection, cerebrospinal fluid leak, deep venous thrombosis, and new neurologic deficit (Table 3).

Postoperative Recurrent Low Back Pain and Influence on Patient-reported Outcomes

At 3 months, none of the patients were found to have a clinically important (above the MCID) decline in low back disability (ODI) compared with baseline, but three (3%) patients were found to have a clinically important (above the minimum clinically important difference) decline in low back pain (NRS) (Table 4).

At 1-year followup, there were 23 (22%) patients who reported clinically important (above the MCID) worsening of low back pain (NRS) or disability (ODI) compared with 3-month levels. The mean change scores from 3 to 12 months for worsening ODI (%), NRS-back, and NRS-leg were 10.70 ± 14.47 , 2.65 ± 2.72 , and 3.08 ± 3.42 , respectively (Table 5). At 2-year followup, there were eight (26%) patients who reported clinically important (MCID) worsening of low back pain (NRS) or disability (ODI) compared with 3-month levels. The mean change scores from 3 to 24 months for worsening ODI (%), NRS-

Table 2. Baseline characteristics of the prospective cohort with 12-month followup

Variable	Number (%)
Number	103
Mean age (years)*	42.9 ± 13.1
Male sex (%)	52 (50)
Motor deficit (%)	48 (47)
Mean number of levels*	1.08 ± 0.28
Current smoker (%)	46 (45)
CAD (%)	6 (6)
HTN (%)	29 (28)
MI (%)	0 (0)
AFIB (%)	1 (1)
CHF (%)	2 (2)
COPD (%)	0 (0)
Arthritis (%)	35 (34)
Diabetes (%)	17 (17)
Osteoporosis (%)	0 (0)
BMI (kg/m^2)*	29.0 ± 6.8
EQ-5D score*	0.49 ± 0.23
SF-12 PCS*	28.73 ± 9.10
SF-12 MCS*	44.34 ± 12.20
ODI score (%)*	52.16 ± 18.42
NRS-back score*	5.56 ± 3.39
NRS-leg score*	7.49 ± 2.35

* Values are mean $\pm$ SD; CAD = coronary artery disease; HTN = hypertension; MI = myocardial infarction; AFIB = atrial fibrillation; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; BMI = body mass index; PCS = physical component summary; MCS = mental component summary; ODI = Oswestry Disability Index; NRS = Numeric Rating Scale.

back, and NRS-leg were 12.70, 4.05, and 2.78, respectively (Table 5).

Recurrence of back and leg pain at 1- and 2-year followup led to worse PROs (Fig. 1). As compared with the patients who showed improvement at 1 year ($n = 80$) versus those who declined at 1 year ($n = 23$), these patients with recurrent back pain reported higher disability (ODI) (13.5 versus 31.9, $p < 0.001$), and poorer quality of life (EQ-5D) (0.86 versus 0.74, $p = 0.003$) and general health state SF-12 PCS (48.1 versus 38.1, $p = 0.002$) and SF-12 MCS (53.1 versus 48.8, $p = 0.08$).

Discussion

Long-term postdiscectomy degenerative disc disease and low back pain is a well-recognized disorder; however, its patient-centered characterization and quantification are

lacking. We performed a systematic literature review and prospective longitudinal study to determine the incidence of recurrent degenerative back pain and quantify its effect on patients' pain, disability, and quality of life.

The limitations inherent in this study have implications for its interpretation. First, there was a high degree of variation in surgical techniques used to perform lumbar discectomy in the literature review. The values deduced from our systematic review only apply for discectomy as a

broad entity and are not necessarily reflective of a specific discectomy technique. Additionally, the level of evidence of studies in the systematic review ranged from Ib to IV. This introduces selection bias, transfer bias, and assessment bias and the estimation of frequency of low back pain is likely to be a low-end estimate. Lastly, our study has no patients with long-term followup (> 2 years) and therefore comparison with the long-term estimate of persistent back/leg pain incidence found in the literature review could not be performed. Another study with a larger sample size and more patients with long-term followup is necessary to further corroborate the results found in our literature review.

In a systematic literature review, we found that the short-term and long-term proportion of recurrent back pain after primary single-level lumbar discectomy ranged from 3% to 34% and 5% to 36%, respectively. The incidence of recurrent disc herniation was 5.3%. Our prospective, longitudinal PRO study validated these literature review findings, suggesting that when applying an MCID threshold of clinically significant deterioration with validated outcome instruments, as many as one in four patients undergoing discectomy may experience a clinically meaningful recurrence of low back pain and dysfunction. Although as many as 25% of patient in our series experienced worsening back pain and disability by 2 years, their level of low back pain and dysfunction remained better than that experienced at the time of the index disc herniation procedure. Furthermore, none of these patients underwent a fusion procedure or operative intervention for these symptoms at 2 years, although it is possible they may come to attention for these symptoms over the longer term. Schoeggl et al. [76] demonstrated that 24% of patients experienced persistent or recurrent pain at a mean followup of 7.3 years. Carragee et al. [13] reported an 11% incidence of persistent back or leg pain after limited discectomy and a 23% incidence of persistent back or leg pain after aggressive discectomy. As such, at least some of the variability observed in the literature may be secondary to varying surgical technique.

Table 3. Operative characteristics of the prospective cohort

Approach	Number (%)
Open microdiscectomy	11 (11)
Tubular microdiscectomy	92 (89)
Operative time (minutes)*	90.42 ± 34.18
Blood loss (mL)*	86.17 ± 117.13
Length of hospital stay (days)	1 (range, 1–2)
Intraoperative complications, number (%)	
Dural tear	1 (1)
Nerve root injury	0
Postoperative complications	
Wound hematoma	1 (1)
Wound infection	3 (3)
Cerebrospinal fluid leak	2 (2)
Deep venous thrombosis	0
New neurological deficit	1 (1)
Recurrent disk herniation (same level)	9 (9)
Disk herniation other level	1 (1)
Return to operating room within 90 days	
Wound infection	1 (1)
Stenosis	0 (0)
Dural tear	0 (0)
Cerebrospinal fluid leak	2 (2)
Cauda equina syndrome	0 (0)

* Values are mean ± SD.

Table 4. Summary of clinical outcomes data for all patients included in the study*

Variable	Preoperative (n = 103)	3 months (n = 103)	1 year (n = 103)	2 years (n = 30)
EQ-5D	0.49 ± 0.23	0.81 ± 0.23	0.83 ± 0.19	0.84 ± 0.14
SF-12 PCS	28.73 ± 9.10	45.82 ± 10.87	45.82 ± 12.03	45.93 ± 10.89
SF-12 MCS	44.34 ± 12.20	53.16 ± 8.99	52.14 ± 9.32	55.06 ± 9.22
ODI	52.16 ± 18.42	17.30 ± 17.26	17.65 ± 18.56	19.33 ± 20.42
NRS-back	5.56 ± 3.39	2.22 ± 2.51	2.88 ± 2.82	2.90 ± 3.12
NRS-leg	7.49 ± 2.35	2.11 ± 2.82	2.51 ± 3.14	2.21 ± 3.11

* Mean ± SD for all variables at each assessment. Significant improvement from baseline was seen for all variables ($p < 0.01$); PCS = physical component summary; MCS = mental component summary; ODI = Oswestry Disability Index; NRS = Numeric Rating Scale.

Table 5. Summary of outcomes reported for 23 of 103 (23%) patients identified as having 1-year and eight of 30 (26%) patients identified as having 2-year recurrent low back pain and disability after discectomy (defined by MCID thresholds)*

Variable	Preoperative (n = 23)	3 months (n = 23)	1 year (n = 23)	2 years (n = 8)
EQ-5D	0.42 ± 0.25	0.82 ± 0.14	0.74 ± 0.16	0.75 ± 0.08
SF-12 PCS	28.25 ± 7.42	43.99 ± 11.31	38.12 ± 13.39	36.67 ± 8.74
SF-12 MCS	40.89 ± 13.89	53.17 ± 10.53	48.76 ± 10.58	53.30 ± 10.75
ODI	59.30 ± 18.43	21.22 ± 18.45	31.91 ± 18.27	33.75 ± 15.69
NRS-back	7.00 ± 2.78	2.70 ± 2.88	5.35 ± 2.53	6.75 ± 1.28
NRS-leg	8.09 ± 1.62	2.22 ± 2.78	5.30 ± 3.14	5.00 ± 3.46

Values are mean ± SD; *despite a delayed decline in these patients, back pain, disability, and quality of life remained improved versus preoperative levels ($p < 0.05$); PCS = physical component summary; MCS = mental component summary; ODI = Oswestry Disability Index; NRS = Numeric Rating Scale; MCID = minimum clinically important difference.

Fig. 1 PROs at baseline, 3 months, 1 year, and 2 years are shown. The blue line represents the complete cohort, whereas the red line represents the patients who showed recurrence of symptoms and decline at 1-year and 2-year followup.

In our prospective study, we found that 9% of patients had radiographic same-level recurrent lumbar disc herniation and 6% were symptomatic enough to undergo a reoperation. The values found in our prospective registry for the frequency of same-level recurrent herniation and reoperation fall neatly within the range from 0% to 23%

found in our literature review. Although the incidence of recurrent disc herniation is less than that of delayed post-operative back pain, its severity is much greater, and patients required reoperation in the majority of cases. Our study demonstrated that recurrence of back and leg pain at 1- and 2-year followup led to worse patient-reported

outcomes at those followup points. Although not a surprising finding, this is the first study to demonstrate that recurrent/persistent back pain after lumbar discectomy results in an associated decline in functional status as measured by validated outcome metrics for disability (ODI), health utility (EQ-5D), and general quality of life (SF-12).

In an analysis of a systematic literature review and prospective longitudinal outcomes study, the proportion of 2-year, same-level disc herniation requiring revision discectomy was nearly 6% in both analyses. Two-year recurrent low back pain after discectomy may occur in 15% to 25% of patients depending on the level of recurrent pain considered clinically significant. Although delayed recurrent back pain exceeding MCID occurs not infrequently, the level of pain and disability remains less than that experienced at the time of prior disc herniation and index surgery. Despite this, recurrent back pain leads to worse PROs including higher disability and poorer general health state (SF-12 PCS and SF-12 MCS) and quality of life (EQ-5D) as demonstrated by the results of our study. Five- and 10-year followup studies are needed to further characterize the frequency and severity of postdiscectomy degenerative low back pain because this can affect long-term PROs as a result of higher preoperative expectations and lead to poor postoperative satisfaction.

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