

Review Article

# An evidence-based review of the literature on the consequences of conservative versus aggressive discectomy for the treatment of primary disc herniation with radiculopathy

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## Abstract

**BACKGROUND CONTEXT:** It remains unknown whether aggressive disc removal with curettage versus conservative removal of a disc fragment with little disc invasion provides a better outcome for the treatment of lumbar disc herniation with radiculopathy.

**PURPOSE:** Determine the level of evidence within the clinical literature that supports the performance of a conservative versus aggressive technique for discectomy.

**STUDY DESIGN/SETTING:** Systematic evidence-based review of clinical literature.

**PATIENT SAMPLE:** Patients with primary lumbar disc herniation with radiculopathy.

**OUTCOME MEASURES:** Operative time, return to work status, recurrent disc herniation, self-reported, and functional measures assessed less than 2 years (short term) and greater than 2 years (long term) after surgery.

**METHODS:** Systematic Medline search was performed to identify all published studies relating to outcome after aggressive or conservative discectomy. Levels of evidence (I–V) were assessed for each study and grades of recommendation were generated (Good, Fair, Poor, Insufficient evidence) based on the NASS Clinical Guidelines' Levels of Evidence and Grades of Recommendation.

**RESULTS:** There is fair evidence that conservative discectomy will result in shorter operative times and a quicker return to work despite similar lengths of hospital stay, similar pain levels at discharge, similar 6-month functional status, and a similar 2-year incidence of persistent/recurrent back and leg pain. There is poor quality evidence that conservative discectomy will result in a lower incidence of recurrent back pain beyond 2 years postoperatively. There is fair quality evidence that conservative discectomy will result in a higher incidence of recurrent disc herniation.

**CONCLUSIONS:** There are no Level I studies to support conservative versus aggressive discectomy for the treatment of primary disc herniation. However, systematic review of the literature suggests that conservative discectomy may result in shorter operative time, quicker return to work, and a decreased incidence of long-term recurrent low back pain but with an increased incidence of recurrent disc herniation. Prospective randomized trials are needed to firmly assess this possible benefit. © 2009 Elsevier Inc. All rights reserved.

## Keywords:

Literature review; Lumbar; Discectomy; Herniated nucleus pulposus; Reherniation; Revision surgery; Failed back syndrome

## Introduction

Over the last several decades, two approaches have dominated the surgical treatment of primary lumbar disc herniation with radiculopathy resistant to conservative treatment. The first, described by O'Connell [1] involved a large open incision with aggressive removal of the disc fragments and curettage of the disc space. The second, described by Spengler [2] emphasized a smaller incision with removal of the disc fragment with little invasion of the disc. This less

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invasive technique relied upon developments in surgical lighting and microscopic techniques in the later half of the 20th century. More recently, a variety of minimally invasive techniques have been developed intended primarily as central disc ablation procedures to treat symptomatic disc herniation (ie, chemonucleolysis, mechanical debridement, radio frequency [RF] ablation, and laser ablation). These latter, minimally invasive techniques have not proven as effective or reliable as the open techniques and are not the focus of this review [3].

The O’Connell approach will be referred to as the “aggressive” discectomy technique in this review. This technique was standard practice for many years and is still frequently used. It has been criticized for possibly causing nucleus and end plate injury, leading to an increased incidence of postoperative back pain and acceleration of degenerative changes on imaging at the operated disc level. The microsurgical approach with minimal disc removal will be referred to as the “conservative” technique in this review. It has been criticized for possibly being associated with a higher incidence of disc reherniation and the need for further surgery. In an effort to identify clinical evidence either supporting or repudiating these criticisms, a systematic review of the literature was done identifying papers that either directly compared these two discectomy techniques or that reported outcomes associated with either of these discectomy techniques. For purposes of this review, outcomes were categorized as immediate (perioperative), short term (less than 2 years postoperatively), and long term (greater than 2 years postoperatively).

## Methods

To initiate an evidence-based analysis of the literature on surgical treatments of primary disc herniation with radiculopathy, four clinical questions were asked:

1. Is either aggressive or conservative discectomy for primary disc herniation with radiculopathy associated with superior immediate (perioperative: less than 28 days) outcomes?
2. Is either aggressive or conservative discectomy for primary disc herniation with radiculopathy associated with superior short-term (less than 2 years) outcomes?
3. Is either aggressive or conservative discectomy for primary disc herniation with radiculopathy associated with superior long-term (greater than 2 years) outcomes?
4. Is either aggressive or conservative discectomy for primary disc herniation with radiculopathy associated with lower rates of recurrent disc herniation?

To answer these questions, search terms were identified and combined with appropriate Boolean connectors and a search was carried out on all 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]) OR (“Laminectomy”[MeSH] AND (“Lumbosacral Region”[MeSH] OR “Lumbar Vertebrae”[MeSH])) AND English[lang] AND (“Treatment Outcome”[MeSH] OR “Outcome Assessment (Health Care)”[MeSH] OR (surgical outcome[All Fields] OR surgical outcomes[All Fields])) Limits: English, Publication Date from 1966 to 2007.

All abstracts obtained from these search criteria were reviewed. Case reports, technical notes, and animal or laboratory studies were discarded. The remaining manuscripts were then read in their entirety and rated as Levels I–V according to the North American Spine Society’s adopted standardized levels of evidence tables [4]. An evidentiary table was developed summarizing each study chosen and assigning a level of evidence based on the primary research question of each study. Two authors independently assigned levels of evidence to each study. Any discrepancies in the assigned level of evidence were discussed between reviewers at the conclusion of evidence rating. If needed, a blinded assessment was made by a third, outside reviewer, to finalize the level of evidence. For Levels I, II, and III studies where aggressive versus conservative discectomy was not the primary research question, the outcomes reported for aggressive or conservative discectomy cohorts were included as Level IV evidence.

Grades of recommendation were assigned for each study question based on the North American Spine Society’s Clinical Guidelines for Multidisciplinary Spine Care [5]: Good evidence (Level I studies with consistent findings), Fair evidence (Level II or III studies with consistent findings), Poor quality evidence (Level IV or V studies with consistent findings), or Insufficient evidence for or against recommending intervention.

## Results

### *Literature search*

The literature search yielded 621 published studies. After reviewing the titles of these 621 studies, case reports, animal studies, opinion-based reviews, and topics not relevant to outcome after discectomy were discarded. This resulted in 92 studies. These 92 abstracts were then reviewed and those abstracts not clearly relating to outcome after lumbar discectomy were also discarded. This process resulted in 39 studies that were felt to be pertinent to answering the questions asked. The full manuscripts of these 39 studies were then reviewed and studies not reporting outcomes in at least one time frame (immediate, short term, or long term) after discectomy were discarded. Twenty-five studies were thus identified that either directly compared aggressive versus conservative discectomy techniques or that reported outcomes associated with either of these discectomy techniques (Table 1). On the basis of the primary

Table 1

Evidentiary table and summary of published studies investigating outcomes after discectomy for the treatment of primary disc herniation with radiculopathy

Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
1. Carragee E, Han M, Suen P, Kim D. Clinical outcomes after lumbar discectomy for sciatica: the effects of fragment type and anular competence. <i>JBJS</i> 2003;85-A: 102–8 [21].	Level I  Prognostic study High-quality prospective study	<i>Conservative discectomy</i>  This is a prospective, observational study of 187 patients who underwent a single-level primary lumbar discectomy by one surgeon. Surgical technique was limited without curettage. 180 patients (96%) were evaluated independently at a minimum of 2 y, and a median of 6 y after surgery. The extent of annular defect was observed at surgery as large (greater than a 6 mm probe), fissure or contained. Four types of herniation were described: fragment fissure; fragment defect; fragment contained (required annulotomy); and no fragment contained (treated with a large annulotomy and defect). Validated outcome measures of Oswestry and visual analog scale were collected and recurrent herniated nucleus pulposus and surgery were recorded.	Intraoperative findings were more closely related to outcomes than were demographic, socioeconomic, or clinical variable. Patients in the fragment-fissure group had the best outcomes scores, lowest recurrence rate (1%), and lowest reoperative rate (1%). Patients in the fragment-contained group had the next best outcomes, a 10% recurrence rate and 5% reoperation rate. Patients in the fragment-defect group had a 27% recurrence rate and 21% reoperation rate. And patients in the no fragment-contained group had the worst clinical outcomes (p<.001).  In critique of this study, quantification of the annulus size was crude.
2. Carragee E, Spinnickie A, Alamin T, Paragioudakis S. A prospective, controlled study of limited versus subtotal discectomy: short-term outcomes in patients with herniated lumbar intervertebral discs and large posterior anular defect. <i>Spine</i> 2006;31:653–7 [7].	Level III  Therapeutic study Really a cohort-control study (historic control group)	<i>Conservative vs. aggressive discectomy</i>  This is a prospective observational study of 30 patients who underwent a posterior subtotal discectomy for lumbar herniated nucleus pulposus. The control group was an historical cohort of 46 patients treated with limited discectomy alone. Reherniation rates and clinical outcomes were determined by an independent evaluation at 6, 12, and 24 mo after surgery.	The authors conclude that in spite of higher reherniation rates for limited discectomy for the period of follow-up, the patient outcomes are superior at 2 y. They now only perform a limited discectomy in their patients and inform them of a possible recurrence.  In critique of the study, this was not a randomized trial and the control was historical. Furthermore, the number of patients was small.

<p>3. Keskimaki I, Seitsalo S, Osterman H, Rissanen P. Reoperations after lumbar disc surgery: a population-based study of regional and interspecialty variations. <i>Spine</i> 2000;25:1500–8 [35].</p>	<p>Level II  Prognostic study Retrospective-multivariate analysis</p>	<p>The reherniation rate in the limited discectomy group was 18% vs. 9% in the subtotal discectomy group (<math>p &lt; .01</math>). However, the visual analog scale (<math>p &lt; .02</math>) and Oswestry scores (<math>p &lt; .06</math>) were at 12 mo for the subtotal group and the return to work was longer with higher use of medication in the subtotal group. Despite the higher herniation rates, the patient satisfaction was greater for the limited discectomy group at 2-y follow-up. <i>Discectomy technique not described</i></p>	<p>The authors conclude that the risk for reoperation was higher than expected (18.9% at 9 y) in this large group of patients and that the risk appeared to be highest with neurosurgeons over orthopedic surgeons. In critique of this study, the use of registry data, even though remarkable complete with a very high level of follow-up in this particular study, does not allow characterization of all patients equally well as to the medical history before entrance into the registry.</p>
<p>4. Katayama Y, Matsuyama Y, Yoshihara H, et al. Comparison of surgical outcomes between macrodiscectomy and microdiscectomy for lumbar disc herniation: a prospective randomized study with surgery performed by the same spine surgeon. <i>J Spine Disord Tech</i> 2006;19:344–7 [8].</p>	<p>Level II Therapeutic study          Lower-quality randomized controlled trial (RCT), baseline intergroup difference, no power analysis for negative conclusions</p>	<p>This retrospective follow-up study looked at 25,359 patients with surgical treatment for herniated nucleus pulposus from the Finnish Hospital Discharge Register. The number of subsequent surgical interventions was investigated. 12.3% of these patients underwent a subsequent surgery. A Kaplan-Meier method and proportional hazard model were used to calculate the cumulative risk of an HNP in this group of patients, which was 18.9% for 9-y follow-up. The risk of reoperation covaried with the original risk of surgery. Overall, neurosurgeons had a higher risk for reoperation when compared with orthopedic surgeons (relative risk 1.57 at 95% confidence level). This was felt to be a result of minimalist approaches and different strategies for surgical intervention. <i>Aggressive discectomy</i> This RCT of 119 patients with a primary herniated nucleus pulposus had 62 of whom were randomized to a macrodiscectomy techniques and 57 of whom received a microdiscectomy technique. The operations were all performed by the same surgeon and follow-up averaged 2 y and 8 mo (12 mo to 4 y). In addition to parameters of the surgical intervention, validated outcome measures of visual analog scale and JOA score were collected before surgery and at discharge from hospital.</p>	<p>Short-term, in-hospital differences were not significant with respect to the frequency of use of an analgesic agent after surgery, the pre- and post-op Japanese Orthopedic Association (JOA) scores or postoperative visual analog scale for sciatica. There were significant differences between the two procedures in the observed operative times, amount of bleeding, duration of hospitalization, and postoperative visual analog scale for back pain, but these differences were not large and the authors felt they were not clinically significant. Thus, short-term outcomes for both procedures were clinically equivalent in the study.</p>

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Table 1 (continued)

Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
5. Gibson J, Waddel G. Surgical interventions for lumbar disc prolapse. Updated cochrane review. <i>Spine</i> 2007;32:1735–47 [36].	Level II Therapeutic study	<i>Discectomy Technique not Described</i> This systematic review of the literature identified 40 RCTs and 2 quasi-RCTs. Many of these trials assessed comparisons of chemonucleolysis to discectomy, percutaneous techniques to open discectomy or different discectomy techniques to each other. This is an update of a previous Cochran review in 1998.	Surgical discectomy for carefully selected patients with HNP provides faster relief than conservative measures. There is strong evidence that open discectomy is superior to chemonucleolysis, which itself is superior to placebo. The evidence for percutaneous discectomy, laser discectomy, and ablative techniques remains unclear.
	Systematic review of Levels I and II studies (high- and low-quality RCTs)		Microdiscectomy was considered to give broadly comparable results to standard discectomy though, in critique of this paper, no specific measurement of recurrent herniations or subsequent surgery was attempted.
6. Loupasis G, Stamos K, Katonis P, Sapkas G, Korres D, Hartofiladidis G. Seven- to 20-year outcome of lumbar discectomy. <i>Spine</i> 1999;22:2313–7 [28].	Level III Prognostic study	<i>Aggressive discectomy</i> This retrospective follow-up study looked at 109 of 152 patients who were surgically treated by an aggressive surgical technique independently analyzed a mean of 12.2 y after their index procedure by a mail questionnaire that included the validated Oswestry instrument and the Stauffer-Coventry criteria for outcome. In 66% of patients, radiographic review was carried out as well. By the Stauffer-Coventry criteria, 36% of the patients had a fair or poor outcome at an average of 12.2 y after surgery. The mean Oswestry score at follow-up, however, was 18.9 with 65% of the patients very satisfied with their results. 28% still complained of significant leg or back pain and 7.3% (eight patients) were reoperated on at an average of 5.9 y after the index procedure. Disc space narrowing was common at the level discectomy in the 66% of patients followed-up with radiographs. These changes did not correlate with any of the outcome measures.	This retrospective study of an aggressive surgical technique for primary discectomy demonstrated a significant percentage of continued back complaints in the patient population (36%). Reoperations occurred at a rate of 7.3% at an average of 5.9 y.
	Retrospective case-control study		In critique of this study, there is no comparison group and the follow-up percentage is only 72%.

<p>7. Fountas K, Kapsalaki E, Feltes C, et al. Correlation of the amount of disc removed in a lumbar microdiscectomy with long-term outcome <i>Spine</i> 2004;22:2521–4 [22].</p>	<p>Level II Prognostic study</p>	<p><i>Conservative discectomy</i> 106 Patients underwent first-time lumbar microdiscectomy by three surgeons for medically refractory sciatica and were prospectively followed for minimum of 2 y. No patients had free-fragment disc or lumbar stenosis. Disc curettage not performed in any patient. Removed lumbar disc was weighed at time of surgery and correlated with outcome. Patients with persistent symptoms underwent magnetic resonance imaging and flexion-extension films. At 2-y f/u, 91 (86%) had no persistent symptoms/signs and returned to work. 15 (14%) had persistent symptoms/signs &gt;6 mo (back and leg pain). Of these, eight (7.5%) had recurrent herniated disc at surgical level, three (3%) had first degree instability at surgical level, four (4%) no radiographic explanation for treatment failure. Amount of disc removed (by weight) did not correlate with recurrent herniation, post-op instability, or persistence of symptoms.</p>	<p>The amount of lumbar disc removed (by weight) did not correlate with 2-y outcome.</p>
	<p>Prospective study with 100% 2-y f/u but no power analysis to support negative association</p>		<p>In critique of this study, although there is good standardization of surgical treatment with 100% 2-y follow-up, a power analysis is not provided to adequately support a definitive negative association between disc weight and outcome.</p>
<p>8. Mariconda M, Galazo O, Secondulfo V, Rotonda G, Milano C. Minimum 25-year outcome and functional assessment of lumbar discectomy. <i>Spine</i> 2006;22:2593–9 [11].</p>	<p>Level III Therapeutic study</p>	<p><i>Aggressive discectomy</i> 348 Consecutive patients having undergone lumbar discectomy for medically refractory sciatica at a single institution by seven surgeons were retrospectively reviewed. 201 (58%) were available to complete outcome survey (all were &gt;25 y after surgery). Discectomy included curettage in all cases and 17% of cases were two-level discectomy. Outcome measures included: Short form-36 (SF-36) questionnaire, Oswestry Disability index (ODI), cumulative illness scale, and 25-y outcomes compared with historical normal controls. At mean f/u of 27.8 y after surgery, ODI was 17.5, and severe disability reported by 16% of patients. 90% were satisfied with their outcome. 28% experienced some degree of persistent pain mean 11.6 y after discectomy. SF-36 score were similar between this series of discectomy patients and age-/sex-matched norms, but better than previously reported patients undergoing conservative management (Apolone et al., 1997).</p>	<p>25 Years after lumbar discectomy for medically refractory sciatica, patients had a high-rate (90%) of satisfaction and a quality of life (SF-32) similar to age-/sex-matched norms. Quality of life (SF-32 scores) for this cohort was improved compared with a previous report of conservatively managed sciatica.</p>
	<p>Retrospective, cohort-control study (historic controls used)</p>		<p>In critique of this study, although an assessment of long-term quality of life is assessed with appropriate methodology, firm conclusions cannot be made based on the intercohort comparisons made. This is because no statistical tests could be applied to the published SF-32 norms and the historical control group of conservative management was not standardized with respect to diagnosis criteria and outcome assessment.</p>

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Table 1 (continued)

Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
9. Yorimitsu E, Chiba K, Toyama Y, Hirabayashi K. Long-term outcomes of standard discectomy for lumbar disc herniation. <i>Spine</i> 2001;6:652–7 [25].	Level III Prognostic study	<i>Conservative discectomy</i> 131 Patients having undergone discectomy for medically refractory sciatica by three surgeons at a single institution were retrospectively reviewed. 72 (55%) were available for follow-up. All patients >10-y follow-up (range, 10–22). Curettage was not performed in any cases, free fat grafts were routinely placed at discectomy site. Four (5%) patients underwent two-level discectomy. The JOA for Low Back Pain score was assessed at last follow-up.	Mean of 14.3 y after lumbar discectomy for medically refractory sciatica, the long-term outcome was favorable. Preservation of disc height during discectomy associated with higher risk of reherniation.
	Retrospective case-control study	At mean of 14.3 y after discectomy, JOA scores improved by a mean of 73.5%, 12.7%, and 9.5% had residual severe low back pain or leg pain, respectively. 12.5% underwent revision lumbar surgery (mean, 5.4 y after discectomy). Increasing pre-op disc degeneration (by discogram) correlated with increased likelihood of long-term back pain. Mean post-op disc height was greater in patients experiencing reherniation. Loss of >25% of pre-op disc height on post-op films was associated with worse long-term JOA score. Long-term JOA did not correlate with pre-op patient age, disc level, degree, or degree of disc herniation.	>25% Loss of disc height and increased preoperative disc degeneration associated with increased risk of persistent severe low back pain. In critique of this study, it provides solid outcome assessment at long-term follow-up. However, the primary reported predictors of outcome were radiographic which were only obtained in 50 patients (discogram) and 40 patients (disc-height measurement) potentially confounding these associations. With lack of multivariate analysis, it is unclear if the disc height and degree of degeneration measures (by discogram) are independent of each other or merely alternative measure of the same factor. Lumbar discectomy results in a high degree of success at 6 mo after surgery. This high degree of success is maintained at 10-y follow-up.
10. Findlay G, Hall B, Musa S, Oliveria M, Simon F. 10-Year follow-up of the outcome of lumbar microdiscectomy. <i>Spine</i> 1998;10:1168–71 [14].	Level IV Therapeutic study	<i>Conservative discectomy</i> 88 Patients undergoing microdiscectomy for medically refractory sciatica resulting from single-level disc herniation were retrospectively assessed at 6 mo and at last follow-up. 90% of patients underwent outcome assessment at 10 y (Macnab classification and Roland-Morris disability score).	



	Retrospective case series (no comparison group)	Macnab defined “good” or “excellent” outcome occurred in 91% and 83% of patients at 6 mo and 10 y after discectomy, respectively. 6% of patients required repeat surgery for disc reherniation. 18% of patient deteriorated by Macnab classification between 6 mo and 10 y, whereas 7% improved between 6 mo and 10 y. There was no significant difference between 6 mo and long-term outcome. Macnab defined outcomes correlated well with Roland-Morris disability scores, validating the reliability of the primary outcome measure. 91% believed that their discectomy was worthwhile.	In critique of this study, it allows assessment of long-term outcomes, but the conclusions of long-term efficacy must be made cautiously. Its retrospective nature with lack of prospective control, do not allow results of this study to be applied to all patients with disc herniation.
11. Gaston P, Marshall RW. Survival analysis is a better estimate of recurrent disc herniation. <i>J Bone Joint Surg</i> 2003;85:535–7 [29].	Level IV Therapeutic study	<i>Conservative Discectomy</i> 993 Consecutive patients undergoing lumbar discectomy for medically refractory sciatica were retrospectively reviewed with varying follow-up (mean, 5.25 y). The primary outcome measure was revision surgery at the same level for ipsilateral or contralateral recurrent disc herniation. The absolute rate of recurrent disc herniation was compared with the estimate cumulative incidence by the Kaplan-Meier method.	In a consecutive group of patients undergoing lumbar discectomy with variable follow-up, the incidence of recurrent disc herniation was likely underestimated as a result of widely variable lengths of follow-up. When utilizing time-dependent events as outcomes, patient follow-up must be controlled or similar between comparison groups if reporting events as absolute incidence. Otherwise, the estimated Kaplan-Meier method is required to adjust for varying follow-up periods.
	Retrospective case series (no comparison group)	Absolute incidence of recurrent disc herniation was 4.9%. By the estimated Kaplan-Meier method, the estimated cumulative 10-y incidence was 7.9%. Preoperative age, gender, or disc level was not found to be associated with recurrent disc herniation.	In critique of this study, it is valuable in that it provides an example of the appropriate use of the Kaplan-Meier survival method in discectomy outcomes studies, but application of the reported relative risk of recurrent disc herniation to all patients should be made cautiously, given the retrospective nature of the study.
12. Henriksen L, Schmidt K, Eskesen V, Jantzen E. A controlled study of microsurgical versus standard lumbar discectomy. <i>Br J Neurosurg</i> 1996;10:289–93 [9].	Level II	<i>Aggressive discectomy</i>	For patients with herniated lumbar discs and refractory sciatica, a smaller fascia incision (3 cm) did not effect length of hospitalization or VAS pain scores within the first 6 wk of surgery when compared with standard discectomy (7 cm fascia incision).
	Therapeutic study	79 Patients (age 20–60 y) with medical refractory sciatica were randomized to undergo microdiscectomy (3 cm fascia incision, 7 cm skin incision) vs. standard discectomy (7 cm fascia incision, 7 cm skin incision). VAS was assessed before surgery, 2, 4, 6 d after surgery, and 2, 4, and 6 wk after surgery by a blinded observer.	

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Table 1 (continued)

Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
	RCT of lesser quality (poor randomization technique)	There were no baseline differences between treatment groups after randomization. Microdiscectomy was associated with a longer operative time (48 vs. 35 min). There were no differences in length of hospitalization, or VAS pain score at any time point between treatment groups.	In critique, the study was appropriately powered to support the negative findings and offers valuable short-term outcome comparisons between micro- and standard discectomy. However, cohort selection was not randomized by appropriate standards and it is not clear if the enlarged 7 cm skin incision used in the microdiscectomy group negatively influenced the outcome of this cohort. Long-term outcome remains unassessed in this study.
13. Hirabayashi S, Kumano K, Ogawa Y, Aota Y, Maehiro S. Microdiscectomy and second operation for lumbar disc herniation. <i>Spine</i> 1993;18:2206–11 [26].	Level III Prognostic study	<i>Aggressive discectomy</i> 214 Patients who underwent microdiscectomy for refractory sciatica at a single institution were retrospectively reviewed. All patients had >2 y follow-up (range, 2–9). Primary outcomes measure was assessed by Kawabata criteria. 16 (8%) underwent two-level discectomy.	For patients with herniated lumbar discs and refractory sciatica, microdiscectomy resulted in favorable outcomes for 80% of patients 2 y after surgery. Both the incidence of “poor” outcome and reoperation were higher in patients whose original discectomy revealed that disc protrusion was confined to below the annulus rather than extruded or free fragment.
	Retrospective case-control study	Outcome was “excellent” or good” in 156 (73%) patients. 7.5% patients required reoperation (4.2% for recurrent disc herniation) and was significantly higher for teenagers. When disc protrusion was confined to below the annulus, 16% had “poor” outcome vs. 0% “poor” outcome in patients with free-fragment discs. Incidence of reoperation was also higher when disc protrusion was confined to below the annulus. Degree of disc resected (by weight) did not correlate with Kawabata outcome score.	In critique, this study uses outdated and a more crude outcome measure subject to subjectivity and unclear reproducibility. The variation in time of last follow-up may result in underestimation of reoperation incidence.
14. Jensdottir M, Gudmundsson K, Hannesson B, Gudmundsson G. 20 Years follow-up after the first microsurgical lumbar discectomies in Iceland. <i>Acta Neurochirurgica</i> 2007;149:51–8 [37].	Level IV Therapeutic study	<i>Conservative discectomy</i> 170 Consecutive patients having undergone microdiscectomy performed at a single institution by two surgeons for refractory radiculopathy as a result of herniated lumbar disc were retrospectively reviewed. 134 (79%) were available for follow-up. Outcomes were categorized as excellent, good, fair, and poor. Mean follow-up was 20.7 y (range, 19.5–22.8). 17 (12.7%) patients underwent surgery for recurrent herniated lumbar disc at a mean of 5.9 y after original surgery. 80.6% returned to their previous level of work and 91% reported “excellent” or “good” (ie, 50–100% reduction in pain) outcome with their surgery. 8% of patients were receiving workers compensation for their back/leg pain at last follow-up.	Long-term outcomes after microdiscectomy for herniated lumbar disc are favorable in the vast majority of patients but are associated with recurrent disc herniation in nearly 13% of cases.
	Retrospective case series (no control group)		In critique, this study is a simple case series with one-arm and no comparison group. It uses subjective outcome measures not definitely proven to have retest reliability.

15. Kowalski J, Olsewski J, Simmons E. Results of Intervertebral discectomy without fusion at L4–5 versus L5–S1. <i>J Spinal Disord</i> 1995;8:457–63 [27].	Level III Prognostic study  Cohort-control study (L4–L5 vs. L5–S1 as prognosticator)	Incidence of workers compensation was greater in women vs. men (17.9% vs. 1.3%). Long-term satisfaction was not affected by the occurrence of recurrent disc herniation. <i>Aggressive discectomy</i> 89 Consecutive patients with radiculopathy having undergone lumbar hemilaminotomy for discectomy at either L4–L5 or L5–S1 performed at a single institution by four surgeons were retrospectively reviewed. Outcomes were assessed by the Oswestry disability score or Smiley-Webster scale. 68 (76%) Were available for follow-up (minimum f/u of 2 y). Mean f/u was 4.25 y. 31 and 37 had surgery at L4–L5 and L5–S1, respectively. There were no baseline differences between these patient cohorts. 85% felt surgery to be successful at last follow-up and did not differ between surgical levels. Oswestry disability was also similar at follow-up between L4–L5 and L5–S1 groups (8.4% vs. 6.4%). Reoperation occurred in 12% of cases and did not differ between groups (10% vs. 14%) with a 5% disc reherniation rate.	Discectomy without fusion can yield satisfactory long-term results when performed at L4–L5 and L5–S1. Recurrent disc herniation and long-term patient satisfaction does not differ as a function of surgical level between L4 and S1.  In critique, this study offers a long-term outcome comparison between two spinal levels of herniated disc pathology. It however, is unclear how the variation in four surgeons techniques may have influenced each cohort's outcomes particularly if surgical level was not divided equally between surgeons. Because of the retrospective nature of this study and lack of standardized follow-up periods, conclusions must be taken cautiously.
16. Padua R, Padua S, Romanini E, Padua L, De Santis E. Ten to 15 year outcome of surgery for lumbar disc herniation: radiographic instability and clinical findings. <i>Eur Spine J</i> 1999;8:70–4 [24].	Level IV Therapeutic study  Case series (no control group)	<i>Conservative discectomy</i> 150 Consecutive patients having undergone first-time hemilaminectomy and discectomy for refractory radiculopathy by a single surgeon were retrospectively reviewed. All patients were followed for a minimum of 10 y (mean, 12.1). Outcome measure included The Roland Disability Questionnaire (RDQ) in 120 (80%) patients, clinical evaluation by independent physician in 68 (56%), and flexion-extension films in 50 (42%). Mean RDQ was 4.3 (0=no disability, 24=sever disability). 95% patients were satisfied with their outcome. On independent exam at LFU, 13% had documented back pain with reduced range of motion. On imaging at LFU, nine (18%) had symptomatic vertebral instability.	Long-term outcomes after standard discectomy for herniated lumbar disc is favorable in the vast majority of patients but may result in symptomatic vertebral instability in as many as 18% of cases.  In critique, treatment standardization is strengthened as a single surgeon experience and long-term follow-up is given. However, there is significant loss to follow-up allowing the minority of patients to receive radiographic imaging. This may bias the reportedly high incidence of instability because failed back patients are more likely to seek follow-up than those with no persistent symptoms.

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Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
17. Stambough J. Lumbar disc herniation: an analysis of 175 surgically treated cases. <i>J Spinal Disord</i> 1997;10:488–92 [17].	Level IV Therapeutic study	<i>Aggressive discectomy</i> 185 Consecutive patients having undergone first-time hemilaminectomy and discectomy for refractory radiculopathy by a single surgeon were retrospectively reviewed. 175 were available for follow-up (94.6%). All patients were followed-up for a minimum of 1 y (mean, 4.5, range, 1.0–8.3). Follow-up was conducted by phone interview in 75% or office visit in 25%. Outcome was classified as excellent, good, fair, and poor (Kahanovitz scale).	Long-term outcomes after standard open discectomy for herniated lumbar disc are favorable in the vast majority of patients.
	Case series (no comparison group)	Excellent or good outcomes were recorded in 91% of patients at last follow-up. Recurrent disc herniation requiring surgery occurred in 4% of patients. 93% were satisfied with their outcome and 77% returned to their preoperative work level. No preoperative variables predicted treatment failure.	In critique, treatment standardization is strengthened as a single surgeon experience and long-term follow-up is given. However, as in all retrospective studies, these results depend highly on patient selection and surgical technique, making application of these conclusions to all cases of herniated lumbar disc pathology difficult.
18. Thome C, Barth M, Scharf J, Schmiedek P. Outcome after lumbar sequestrectomy compared with microdiscectomy: a prospective randomized study. <i>J Neurosurg Spine</i> 2005;2:271–8 [6].	Level II Therapeutic study	<i>Conservative vs. aggressive discectomy</i> 84 Patients with refractory radiculopathy with free-subligamentary or transanular herniated discs were randomized to microdiscectomy (annulus cut and disc space entered for further disc removal, n=42) vs. sequestrectomy (only herniated disc removed, intervertebral space not entered, n=42). Outcomes assessed included pain level, Patient satisfaction index, Prolo score, and SF-36. 73 (87%) patients were available for follow-up >12 mo postoperatively. Perforated annulus was found in 55% of microdiscectomy cases and 49% sequestrectomy. There were no differences in baseline or treatment variables between groups. Preoperative VAS pain scores were significantly reduced after both treatments and did not differ between treatment groups at discharge, 4, and 12 mo after surgery. Reoperation for recurrent herniation was similar between treatment groups (microdiscectomy 5% vs. sequestrectomy 10%). By Prolo scale, 76% of microdiscectomy and 92% of sequestrectomy patients reported good or excellent outcome. 18% were unsatisfied after microdiscectomy vs. only 3% after sequestrectomy, p=.06.	Sequestrectomy vs. microdiscectomy does not result in a higher incidence of recurrent disc herniation and offers comparable improvement in back and sciatic pain by 12 mo after surgery.
	High-quality RCT (appropriate randomization and >80% f/u, no power analysis for negative conclusion)		In critique, this is a well-conducted RCT. However, a power analysis was not reported to confirm adequate statistical power to validate these negative findings. Also, the incidence of recurrent herniation and treatment failure at 2 and 5 y after surgery are known to vary from that observed at 1 y. This study does not address these relevant long-term outcomes.

<p>19. Tureyen K. One-level one-sided lumbar disc surgery with and without microscopic assistance: 1-year outcome in 114 consecutive patients. <i>J Neurosurg Spine</i> 2003;99:247–50 [10].</p>	<p>Level I Therapeutic study</p>	<p><i>Aggressive discectomy</i> 114 Patients with refractory radiculopathy undergoing either microdiscectomy (no/minimal bone removal, n=63) or macrodiscectomy (hemilaminectomy, n=51) for first-time, one-level, one-sided lumbar disc herniation were prospectively studied. Outcomes were assessed at 1 y by the modified Stauffer-Coventry criteria and assessment of physical signs.</p>	<p>Microdiscectomy vs. macrodiscectomy results in a comparable incidence of recurrent disc herniation, similar length of hospitalization, and offers comparable overall surgical outcome by 12 mo after surgery. Microdiscectomy resulted in greater operative time but allowed earlier return to work and less use of outpatient analgesic agents.</p>
	<p>High-quality RCT (randomization process blinded and &gt;80% f/u)</p>	<p>Good or excellent outcome was observed in 89% and 90% in the micro- vs. macrodiscectomy groups. One (2%) in each group underwent reoperation. Mean operative time was greater in the microdiscectomy group (54 vs. 25 min). Length of hospital stay was similar between groups. Microdiscectomy patient more frequently returned to work within 1 mo (85% vs. 58%) and less frequently required narcotics between 1 and 12 mo after surgery (15% vs. 45%).</p>	<p>In critique, this RCT offers assessment perioperatively and at 1 y only. The incidence of recurrent herniation and treatment failure at 2 and 5 y after surgery are known to vary from that observed at 1 y. This study does not address these relevant long-term outcomes.</p>
<p>20. Errico T, Fardon D, Lowell T. Open discectomy as treatment for herniated nucleus pulposus of the lumbar spine. <i>Spine J</i> 2003;3:45S–9S [38].</p>	<p>Level V Therapeutic study Expert opinion (nonsystematic review)</p>	<p><i>Discectomy technique not described</i> This is a nonsystematic and incomplete review of the literature reporting outcomes after discectomy for herniated lumbar disc for radiculopathy. A historical background, literature review, and expert recommendations are provided. Analysis of the reviewed literature is not performed.</p>	<p>Patients with herniated lumbar disc with radicular symptoms should be treated by nonsurgical means for 4–8 wk, unless there is progressive loss of motor, bladder, or bowel function or excruciating pain that cannot be relieved. Those failing conservative management may then be offered surgical discectomy. Delay for longer than 6 mo in the face of persistent radicular symptoms may compromise the best ultimate result.</p>
<p>21. Moore A, Chilton J, Uttley D. Long-term results of microlumbar discectomy. <i>Br J Neurosurg</i> 1994;8:319–26 [23].</p>	<p>Level II Therapeutic study</p>	<p><i>Conservative discectomy</i> 100 Consecutive patients with refractory unilateral sciatica undergoing first-time lumbar microdiscectomy by a single surgeon were prospectively studied. In all cases, prolapsed disc was removed and annulus not cut. Outcomes were assessed at excellent, good, or poor at 6 wk, 3–7, and 7–11 y after surgery.</p>	<p>Long-term outcomes after microdiscectomy for herniated lumbar disc are favorable in the vast majority of patients. Need for reoperation may occur in up to 8% of patients.</p>
	<p>Prospective longitudinal study (single treatment arm)</p>	<p>91% Of patients returned to work within 6 wk of surgery. 8 (8%) patients underwent reoperation for recurrent disc herniation. All patients were available for follow-up between 3 and 7 y after surgery. 98% patients experienced good-excellent outcome, only two (2%) did not experience symptom improvement. By last follow-up (mean, 8.6 y), 7% reported no improvement in preoperative symptoms.</p>	<p>In critique, this study does not assess outcome at standardized intervals and used a subjective outcome measure without proven retest reliability.</p>

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Table 1 (continued)

Article	Level (I–V)	Description of study (including analysis of methodological strengths/weaknesses and results)	Conclusion/critique
22. Daneyemez M, Sali A, Kahraman S, Beduk A, Seber N. Outcome analyses in 1072 surgically treated lumbar disc herniations. <i>Minim Invasive Neurosurg</i> 1999;42:63–8 [15].	Level IV	<i>Aggressive discectomy</i>	Long-term outcomes after discectomy for herniated lumbar disc is favorable in the vast majority of patients. Need for reoperation may occur in up to 8% of patients. Epidural scar formation comprises a large proportion of recurrence of same level radicular symptoms.
	Therapeutic study	1072 Consecutive patients with refractory unilateral sciatica undergoing first-time lumbar discectomy at a single institution by multiple surgeons were retrospectively studied. Two-level surgery in 16%, three-level in 4%, and one-level in 80%.	In critique, this study does not clearly indicate the length of follow-up. Furthermore, this study does not assess outcome at standardized intervals and used a subjective outcome measure without proven retest reliability.
	Case series (no control group)	Perioperatively, 18 (1.8%) and 17 (1.7%) patients experienced surgical site infection or postsurgical discitis. 85 (8%) underwent reoperation, 30 (2.8%) for disc reherniation. Epidural fibrosis was the most common finding at same level of reoperation. Improvement in back pain and radicular symptoms was reported in 91% of patients.	
23. Lowell T, Errico T, Fehlings M, DiBartolo T, Ladosi L. Microdiscectomy for lumbar disk herniation: a review of 100 cases. <i>Orthopedics</i> 1995;18:985–90 [16].	Level III	<i>Aggressive discectomy</i>	Long-term outcomes after microdiscectomy for herniated lumbar disc are favorable in the vast majority of patients. Women were less likely to experience complete resolution of symptoms. Spinal level discectomy was not associated with variability in outcome.
	Prognostic study	100 Consecutive patients with refractory unilateral sciatica undergoing first-time lumbar microdiscectomy at L4–L5 or L5–S1 by a single surgeon were retrospectively studied. Outcomes were categorized as excellent, good, fair, or poor.	In critique, this study does not standardize length of follow-up, potentially underestimating the incidence of recurrent disc herniation or long-term treatment failure. Furthermore, this study used a subjective outcome measure without proven retest reliability.
	Case-control study	Mean follow-up was 3.1 y (range, 1–6.2 y). By last follow-up, 89% experienced good-excellent outcome (no symptoms or markedly reduced symptoms) and did not differ between L4–L5 vs. L5–S1 levels. 9% failed to return to their preoperative level of activity. 3 (3%) experienced recurrent herniation. A trend suggested worse outcomes with increasing age. Women were less likely to experience complete resolution of symptoms.	

<p>24. Hoffman R, Wheeler K, Deyo R. Surgery for herniated lumbar discs: a literature synthesis. <i>J Gen Intern Med</i> 1993;8:487–96 [39].</p>	<p>Level III Therapeutic study</p>	<p><i>Discectomy technique not described</i> A systematic literature review was conducted via MEDLINE from 1966 through 1991 to identify all published studies of standard, micro-, and percutaneous discectomy that included outcome, complication, and reoperation data. Two investigators independently evaluated the articles for inclusion criteria (sample size &gt;30, adult patients, follow-up data available &gt;75%, minimum follow-up of 1 y or mean of 2 y). Outcomes for all studies were redefined as “successful” when no or only minimal sciatica was present at last follow-up and did not affect functional ability or return to work. Methodological quality was assessed as Levels I–VI by Sackett criteria.</p>	<p>In a 1993 systematic literature review, only two studies offered Level I evidence of the efficacy of lumbar discectomy for refractory sciatica and suggested superior 1-y relief of sciatica vs. conservative care. Lesser quality studies suggest successful outcome for the vast majority of patients undergoing discectomy, regardless of surgical approach. Reoperation may be required in up to 10% of patients.</p>
<p>Systematic review of literature (includes Level III studies)</p>		<p>436 Studies on lumbar disc surgery identified, but only 81 studies met inclusion criteria. Of these, 19 compared two treatment cohorts. Hence, 100 treatment cohorts were reviewed. 72 (81%) were poor quality (Level IV or V) and only 2 (3%) were RCTs. For Level I studies, standard discectomy vs. conservative care provided better 1-y sciatic relief (65–85% vs. 36%). By meta-analysis of Levels 3–5 studies, standard, micro-, and percutaneous discectomy resulted in successful outcomes in 67%, 79%, and 71%, respectively. Overall, 10% of discectomy patients underwent further back surgery.</p>	<p>In critique, this study was performed 13 y ago and therefore does not include many recent studies that meet Level I and Level II methodological qualities.</p>
<p>25. Schmid UD. Microsurgery of lumbar disc prolapse. Superior results of microsurgery as compared to standard and percutaneous procedures. A review of the literature. <i>Nervenarzt</i> 2000;71:265–74 [3].</p>	<p>Level III Therapeutic study</p>	<p><i>Discectomy technique not described</i> A systematic literature review was conducted via MEDLINE from 1985 through 1996 to identify all published studies of standard, micro-, and percutaneous discectomy.</p>	<p>Microdiscectomy more frequently resulted in improved and good outcomes when compared with standard discectomy in a systematic literature review. Compared with these open techniques, percutaneous techniques were associated with decreased “success” with increased reherniation rates.</p>
<p>Systematic review of literature (includes Level III studies)</p>		<p>Compared with standard discectomy, microdiscectomy was “successful” more often (90% vs. 95%), “good/excellent outcome” more often (82% vs. 73%), and was associated with decreased length of hospitalization, but recurrence rates were comparable (4%). Standard and microdiscectomy were superior to any type of percutaneous treatment: “successful” in 69% of chemonucleolysis, 70% of laser therapy, and 84% of endoscopic nucleotomy. Recurrence rates were also higher in percutaneous techniques (mean, 16%).</p>	<p>In critique, the study populations combined for this meta-analysis were highly heterogenous, limiting the conclusions that can be drawn from direct cohort comparison. Furthermore, the follow-up time periods from which outcome measures were assessed were not standard.</p>

Table 2

Summary of short-term outcome (<2 y postoperative), long-term (>2 y postoperative) outcome, and recurrent disc herniation after conservative or aggressive discectomy for primary disc herniation with radiculopathy

Conservative discectomy	Short-term (<2 y) persistence back or leg pain/fair to poor outcome	Long-term (>2 y) persistence back or leg pain/fair to poor outcome	Recurrent herniation
Carragee et al. [21]	—	21/180 (11.7%)	16/180 (8.9%)
Carragee et al. [7]	5/46 (11%)*	—	9/46 (18%)
Fountas et al. [22]	—	15/106 (14%)	8/106 (7.5%)
Yorimitsu et al. [25]	—	16/131 (12.7%)	9/72 (12.5%)
Findlay et al. [14]	7/79 (9%)	13/79 (16%)	5/79 (6%)
Gaston and Marshall [29]	—	—	78/993 (7.9%)
Henriksen et al. [9]	—	12/134 (9%)	17/134 (12.7%)
Padua et al. [24]	—	15/120 (13%)	—
Thome et al. [6]	3/42 (8%)	—	2/42 (5%)
Moore et al. [23]	—	7/100 (7%)	8/100 (8%)
Range	8–11%	7–16%	5–18%
Cumulative total	9% (15/167)	11.5% (98/850)	8.7% (152/1752)
Aggressive discectomy	Short-term (<2 y) persistence back or leg pain/fair to poor outcome	Long-term (>2 y) persistence back or leg pain/fair to poor outcome	Recurrent herniation
Carragee et al. [7]	7/30 (23%)*	—	2/30 (9%)
Loupasis et al. [28]	—	36/101 (36%)	3/104 (3%)
Mariconda et al. [11]	38/201 (19%)	57/201 (28%)	—
Hirabayashi et al. [26]	—	58/214 (27%)	9/214 (4%)
Kowalski et al. [27]	—	13/68 (19%)	5/89 (5%)
Stambough et al. [17]	16/175 (9%)	—	7/175 (4%)
Thome et al. [6]	10/42 (24%)	—	4/42 (10%)
Tureyen [10]	12/114 (11%)	—	2/114 (2%)
Daneyemez et al. [15]	93/1070 (9%)	—	30/1070 (3%)
Lowell et al. [16]	11/100 (11%)	—	3/100 (3%)
Range	9–24%	19–36%	2–10%
Cumulative total	11.1% (187/1690)	28% (164/584)	3.3% (65/1938)

The incidence of persistent back/radicular pain or “fair to poor” outcome (per the Kawabata et al. [18], Macnab [19], or Stauffer criteria [20]) is given for each follow-up time period.

\* Incidence refers to persistent back/leg pain requiring narcotic use.

research question of this review (outcome of conservative vs. aggressive discectomy), no (0%) studies were assigned as Level I evidence, one (4%) was assigned as Level II evidence, one (4%) was assigned as Level III evidence, 18 (72%) were assigned as Level IV evidence, and none (0%) was assigned as Level V evidence. Five studies did not specify the specific technique of disc removal.

#### Immediate outcome

No Level I studies have compared immediate postoperative outcomes after conservative versus aggressive discectomy. Level II evidence was available in only one study [6]. Thome et al. demonstrated that conservative versus aggressive discectomy significantly reduced operative time (mean, 32.6 vs. 38.2 min,  $p < .05$ ) but resulted in comparable blood loss (mean, 78 vs. 61 mL), hospital stay (mean, 2.8 vs. 2.9 d), and visual analog scale (VAS) back pain score postoperative Day 3 (mean, 1.6 vs. 1.4) [6].

Level III evidence was available in one study [7]. Carragee et al. demonstrated that conservative discectomy was associated with a quicker return to work (mean, 12 vs. 28 d,  $p < .05$ ) and a quicker return to full working capacity

(mean, 24 vs. 56 d,  $p < .05$ ) when compared with aggressive discectomy [7].

Level IV evidence was available from three cohorts of aggressive discectomy patients [8–10] but no cohorts of conservative discectomy were available. After aggressive discectomy, reported length of hospitalization ranged from 1 to 8.4 days (median, 4.9) [8–11] and mean duration to return to work was 93 days.

#### Short-term outcome

No Level I studies have compared short-term outcomes after conservative versus aggressive discectomy. Level II evidence was available in one study, which demonstrated no differences in short-term outcome between conservative and aggressive discectomy [6]. Thome et al. demonstrated that conservative versus aggressive discectomy resulted in similar Short form-36 score 6 months after surgery as well as similar back and leg VAS pain scores 1 year after surgery (mean back VAS: 1.6 vs. 1.0; mean leg VAS: 0.8 vs. 0.6). Furthermore, percentage of patients experiencing “excellent” to “good outcomes” (Prolo scale) [12] did not significantly differ between



conservative versus aggressive discectomy 1 year after surgery (92% vs. 76%).

Level III evidence was available in one study, which did not demonstrate a consistent difference in short-term outcome between conservative and aggressive discectomy [7]. Carragee et al. demonstrated that conservative versus aggressive discectomy was associated with better VAS back pain scores and Oswestry scores 1 year after surgery (mean, 1.8 vs. 3.0,  $p < .05$  and 17.4 vs. 24.6,  $p = .06$ , respectively). However, there were no differences in VAS or Oswestry scores [13] when assessed 2 years postoperatively. The percentage of patients requiring narcotics for persistent back or leg pain 2 years after surgery was similar after conservative versus aggressive discectomy (10% vs. 11%).

Level IV evidence was available from three reported cohorts of conservative discectomy [6,7,14] and seven reported cohorts of aggressive discectomy patients [6,7,10,11,15–17] (Table 2). The reported incidence of “fair” to “poor” short-term outcome per the Kawabata et al. [18], Macnab [19], or Stauffer criteria [20] (persistence of back or leg pain) ranged from 8% to 11% for the conservative discectomy cohorts and ranged from 9% to 24% for the aggressive discectomy cohorts. The cumulative incidence of “fair” to “poor” short-term outcome reported in Level IV studies was similar between the conservative and aggressive discectomy cohorts (9% vs. 11.1%,  $p = .41$ , Chi-squared test) (Table 2).

#### *Long-term outcome*

No Level I, Level II, or Level III studies have assessed long-term outcomes after conservative versus aggressive discectomy. Level IV evidence was available from seven reported cohorts of conservative discectomy patients [9,14,21–25] and four reported cohorts of aggressive discectomy patients (Table 2). The reported incidence of “fair” to “poor” long-term outcome per the Kawabata et al. [18], Macnab [19], or Stauffer criteria [20] (persistence of back or leg pain) ranged from 7% to 16% for the conservative discectomy cohorts and ranged from 19% to 36% for the aggressive discectomy cohorts (Table 2). The cumulative incidence of “fair” to “poor” long-term outcomes reported in Level IV studies was lower with conservative than with aggressive discectomy (11.5% vs. 28%,  $p < .001$ , Chi-squared test) (Table 2).

#### *Recurrent disc herniation*

No Level I studies have assessed recurrent disc herniation after conservative versus aggressive discectomy. Level II evidence was available in one study, which demonstrated a 7% overall incidence of recurrent disc herniation that did not significantly differ between conservative versus aggressive discectomy [6]. However, this comparison included only short-term follow-up (less than 2 years). Level III evidence was available in one study, which demonstrated

a trend of increased recurrent disc herniation 2 years after conservative versus aggressive discectomy (18% vs. 9%,  $p = .10$ ) [7].

Level IV evidence was available from nine reported cohorts of conservative discectomy patients [6,7,9,14,21–23,25,29] and nine reported cohorts of aggressive discectomy patients [6,7,10,15–17,26–28] (Table 2). The reported incidence of recurrent lumbar disc herniation ranged from 6% to 18% for the conservative discectomy cohorts and ranged from 2% to 9% for the aggressive discectomy cohorts. Cumulative incidence of recurrent lumbar disc herniation was greater in the conservative versus aggressive discectomy cohorts (8.7% vs. 3.3%,  $p < .001$ , Chi-squared test) (Table 2). When only including Level IV studies with greater than 2-year follow-up, the cumulative incidence of recurrent disc herniation remained greater in the conservative versus aggressive discectomy cohorts (8.5% vs. 4.1%,  $p < .05$ , Chi-squared test).

#### *Grades of recommendation*

There is fair evidence that conservative discectomy will result in shorter operative times and a quicker return to work despite similar length of hospital stay, similar pain level at discharge, similar 6-month functional status, and a similar 2-year incidence of persistent/recurrent back and leg pain. There is poor quality evidence that conservative discectomy will result in a decreased incidence of recurrent low back pain beyond 2 years postoperatively. There is fair quality evidence that conservative discectomy will result in a higher incidence of recurrent disc herniation.

## **Discussion**

In a systematic literature review of published outcomes associated with primary lumbar discectomy for disc herniation with radiculopathy, we determined that there currently is no good evidence (Level I) to support a conservative versus aggressive approach to discectomy. Given the best available data to date, there is fair quality evidence to suggest that removal of the herniated disc fragment alone rather than aggressive disc curettage allows for shorter operative time and a quicker return to work [6,7]. Given that the mean difference in operative time was only 5.6 minutes, the clinical value of this benefit is unclear [6]. However, the 2-week accelerated return to work and 1-month accelerated return to full work capacity reported with conservative discectomy carries clear clinical value [7]. Fair quality evidence also suggests that there is no consistent difference in functional status or recurrent back pain between surgical techniques within the first 2 years of discectomy [6]. Given that the conservative technique is associated with improved perioperative outcome without detriment to short-term outcome, conservative rather than aggressive discectomy may be warranted

based on this fair quality data in the absence of Level I studies.

Long-term outcomes between these two discectomy techniques have not been assessed in any prospective or retrospective comparison studies, making any comparative conclusions limited. In our cumulative comparison analysis of previously reported case series and cohorts from comparative studies addressing other primary questions, a significant increase in the incidence of long-term recurrent back and leg pain was reported with the aggressive versus conservative technique (28% vs. 11.5%). This finding, however, is poor quality evidence limited by variability in baseline patient characteristics, surgical selection, treatment bias, and nonvalidated outcome measures (Kawabata et al. [18], Macnab [19], or Stauffer criteria [20]). Nevertheless, biomechanical studies support the notion that increased disc disruption will accelerate degenerative disc disease and transfer axial loads radially to the innervated annulus fibrosis and to the posterior column facet joints [30–32]. This creates the potential for two postoperative pain generators (degenerative disc and facet pathology). Given the expected time course of degenerative pathology, it is logical that these potentially detrimental effects of disc curettage may not clinically manifest themselves for many years, highlighting the importance of long-term outcome analysis in comparison of these discectomy techniques. Yorimitsu et al. demonstrated that Japanese Orthopedic Association [33] low back pain scores, a validated outcome measure, were significantly worse 10 years after discectomy in patients with greater than 25% loss of preoperative disc height on postdiscectomy radiographs [25]. Furthermore, disc height loss of this nature has been reported to occur in the majority (66%) of patients after aggressive discectomy [28]. Given that fair quality evidence favors conservative discectomy in the immediate short term, this lesser quality evidence favoring a long-term benefit with conservative discectomy should not be ignored, especially given the large volume of Level IV clinical data [9,14,21–25,30–32] and biomechanical data [11,26–28] that supports these findings.

The effect of conservative versus aggressive discectomy on recurrent lumbar disc herniation has been assessed in both the Level II and Level III studies. However, analysis of this endpoint was limited in both studies. Although Thome et al. reported a similar incidence of recurrent disc herniation between discectomy techniques, this assessment was made only 1 year after surgery in most patients [6]. Carragee et al. demonstrated a twofold increase in the incidence of recurrent disc herniation with the conservative technique (18% vs. 9%). However, this twofold difference did not achieve statistical significance given the small sample size of the study [7]. In our cumulative comparison analysis of previously reported case series and cohorts from other comparative studies (Level IV data), a significant increase in recurrent disc herniation was reported with conservative versus aggressive discectomy (8.7% vs. 3.3%).

Given that recurrent disc herniation is a time-dependent event increasing with time after surgery [29], we also compared the cumulative incidence of recurrent disc herniation after excluding studies with less than 2 years of follow-up. This also suggested a significant increase in the long-term incidence of recurrent disc herniation with conservative discectomy (8.5% vs. 4.1%).

It is important to note that our search criteria were aimed to identify studies addressing the primary research question of our review (outcomes comparison between conservative and aggressive discectomy). Studies comparing discectomy to conservative therapy (such as the SPORT trial) [34] or alternative treatments (ie, chemonucleolysis, mechanical debridement, RF ablation, and laser ablation) were not reviewed here. Therefore, this review does not aim to yield a comprehensive review of all reported discectomy cohorts of poor quality evidence (Level IV), but rather a comprehensive review of all good and fair quality evidence to generate grades of recommendation.

Without Level I evidence comparing outcomes of conservative versus aggressive discectomy, definitive conclusions cannot be drawn to firmly validate one approach over the other. However, given that one of these techniques must be used for the open surgical treatment of disc herniation regardless of the approach, and given that there is fair quality data supporting the conservative technique, conservative discectomy may be warranted based on the best available evidence to date. Nevertheless, evidence suggesting an increased incidence of recurrent disc herniation must be considered in the long-term management of these patients when choosing the conservative technique.

## Conclusions

There are no Level I studies to support conservative versus aggressive discectomy for the treatment of primary disc herniation. Systematic review of the literature suggests that conservative discectomy may result in shorter operative time, quicker return to work, and a decreased incidence of long-term recurrent back pain. Conservative discectomy, in spite of these advantages however, appears to result in an increased incidence of long-term recurrent disc herniation. Prospective randomized trials are needed to firmly assess the possible benefits and deficits of conservative discectomy in the patient with a symptomatic, first-time disc herniation unresponsive to conservative care.

## References

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