Does Surgical Timing Influence Functional Recovery After Lumbar Discectomy? A Systematic Review

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Abstract

Background The impact of the duration of preoperative symptoms on outcomes after lumbar discectomy has not been sufficiently answered in a single study but is a potentially important clinical variable.

Questions/purposes A systematic review was performed to answer two questions: (1) Does symptomatic duration before surgery influence functional recovery after lumbar discectomy? (2) What is the time point for intervention beyond which the extent of postoperative recovery might be compromised?

Methods The systematic review began with a query of PubMed using a structured algorithm comprised of medical subject heading terms. This was supplemented by a keyword search in PubMed along with queries of Embase, Scopus,

and Web of Science and searches of reference lists as well as the tables of contents of relevant journals. Eligible studies were those that evaluated aspects of recovery after elective discectomy and stratified duration of symptoms before surgery. Included papers were abstracted by two authors and determinations regarding the period of symptom duration and its impact on outcome were recorded. Eleven studies met all inclusion criteria. No prospectively randomized trials addressed our study questions.

Results Nine of 11 studies, four of which were prospective, maintained that longer symptom duration adversely impacted postsurgical recovery. There were substantial differences among the critical periods of symptom duration reported by individual studies, which ranged from 2 to 12 months. A preponderance of studies (five of nine) reported that surgical interventions could be performed at periods of 6 months or greater without impacting recovery.

Conclusions Longer symptom duration had an adverse impact on results in most studies after lumbar discectomy. A possible point beyond which outcomes may be compromised is 6 months after symptom onset. Limitations in the literature surveyed, however, prevent firm conclusions.

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Introduction

Since it was first described in 1933 [7], lumbar discectomy has become a widely accepted intervention for radiculopathy caused by acute herniation of the lumbar intervertebral disc [2, 7, 12, 15, 18]. Although over time numerous technical iterations have been introduced, including microscope-assisted discectomy, use of minimally invasive tubular retractors, and endoscopic techniques, the underlying principle of the procedure remains unchanged from that proposed by Mixter and Barr [7]: removal of

compressive and irritant disc material from the vicinity of the affected nerve root [15]. The advantages of surgical intervention in this setting, and its effectiveness as compared with nonoperative management, have been highlighted in several high-quality publications, including the prospective Maine Lumbar Spine Study [2] and the Spine Patient Outcomes Research Trial (SPORT) [18].

Although the efficacy of surgical intervention has been widely accepted by the spine surgical community (although by no means as a first-line intervention in most cases), the question remains as to whether the timing of intervention and the duration of symptoms before surgery can have a deleterious impact on results. This question has not been effectively answered through high-quality, scientifically rigorous research, and conflicting reports exist both in regard to the impact that symptomatic duration has on surgical outcome as well as the exact time period beyond which results may be compromised [1, 6, 9, 15]. For example, classic studies by Hurme and Alaranta [6] as well as Nygaard et al. [11] maintained that increased symptom duration diminished results after lumbar discectomy. Meanwhile, a more recent publication from Suzuki et al. [17] failed to find an association between the timing of surgical intervention and postoperative outcome. Likewise, some investigators have reported that symptoms may be present for a period of up to 1 year without influencing surgical results [9], whereas others have claimed that diminution occurs once symptoms have persisted for a period of only 1 to 2 months [6].

Given the lack of consensus in the existing literature, we sought to perform a systematic review to answer the following questions: (1) Does symptomatic duration influence functional recovery after lumbar discectomy for radiculopathy caused by a herniated intervertebral disc? (2) What is the time point for surgical intervention beyond which the extent of postoperative recovery might be compromised?

Search Strategy and Criteria

The search began with a query of the published literature catalogued in PubMed from 1966 to August 28, 2013, using a structured algorithm comprised of medical subject heading terms (lumbar vertebrae AND intervertebral disc displacement/surgery AND time factors AND treatment outcome). A supplemental search was also performed in PubMed using the key words “symptom duration” and “surgical timing” in successive combinations with the key words “disc herniation” and “sciatica”. Similar searches were performed in Web of Science and Scopus, and a query of Embase was conducted using the Emtree algorithm: (‘intervertebral disc hernia’/exp AND ‘outcome assessment’/exp) AND (‘intervertebral disc hernia’/exp OR intervertebral disc hernia’

AND ‘disease duration’/exp OR ‘disease duration’). The catalogued tables of contents of *Clinical Orthopaedics and Related Research*®, *Journal of Bone and Joint Surgery (American)*, *Spine*, *The Spine Journal*, *European Spine Journal*, *Journal of Spinal Disorders and Techniques*, *Journal of Neurosurgery*, and *Journal of Neurosurgery: Spine* were searched electronically using the same dates to identify additional relevant articles. Lastly, a manual search was performed of the reference lists of works found to meet inclusion criteria to identify studies that were missed in the initial search strategy.

Titles and abstracts of investigations included in the results of each query were assessed and full-text articles were reviewed if the study was thought to meet inclusion criteria.

Eligible studies were determined, a priori, to be those that reported results after nonemergent lumbar discectomy, for radiculitis or radiculopathy, stratified by the duration of symptoms from onset of diagnosis to time of surgery. The influence of symptom duration on outcome also had to be evaluated by statistical testing and significance reported using p values and/or an effect size with 95% confidence intervals. Investigations that included patients with cauda equina syndrome, acute motor paralysis, or bowel or bladder incontinence were excluded as were those in which no surgery was performed or the performance of surgery could not be definitively determined. In cases in which the influence of symptom duration on outcome was reported separately for nonsurgical and surgical patients, only the results for the surgical cohort were considered. If multiple reports documented results from the same series of patients (eg, SPORT trial [13, 18], Leiden-Hague Prognostic Study Group [12], etc), only the investigation that specifically reported results by symptom duration or the most comprehensive analysis in terms of study length (eg, 4-year results used in lieu of 2-year outcomes) were used.

Initial determinations regarding study inclusion were made independently by both authors (AJS, CMB), and disagreements were resolved through discussion and consensus. Included papers were abstracted to identify authors, year of publication, number of patients included in the study, study design, determinations regarding the period of symptomatic duration, manner of statistical analysis, and outcomes. Study quality was graded as level I for prospective randomized trials, level II for prospective cohort studies, level III for retrospective case-control investigations, and level IV for retrospective case series. For the purposes of this review, retrospective analyses of prospectively collected data, or post hoc assessments for heterogeneity of treatment effects, were considered level III quality. The literature search and manner of reporting were performed in accordance with the recommendations of the Preferred Reporting of Items for Systematic Reviews

Fig. 1 An algorithm depicting the result of the systematic search, including the number of articles identified and excluded at each juncture.

and Meta-analyses (PRISMA) statement [8]. Final determinations were presented with an evidentiary grade using the system proposed by Schünemann and colleagues [16], which takes into account strength of recommendation and quality of supporting evidence. In this schema, strong recommendations result from multiple studies demonstrating consistent and unambiguous results. Consistent findings from multiple controlled trials or rigorous observational studies are considered high-quality evidence, whereas anomalous results from single observational studies or trials with flaws are declared low quality.

The initial literature search returned 266 published studies. A total of 247 investigations were excluded

following assessment of title and abstract or as duplicate citations identified in multiple searches, leaving 19 full-text articles that were reviewed (Fig. 1). After full-text review, eight publications were further excluded (Appendix 1) with the remaining 11 studies [1, 3–6, 9–11, 13, 14, 17] found to meet all inclusion criteria (Table 1). The included investigations were published between 1987 and 2011. No prospective randomized trials were identified. Four studies were graded as level II quality and seven were graded as level III. Only six (55%) were specifically designed with the intent of investigating the influence of symptom duration on outcome after lumbar discectomy.

Table 1. Results of investigations that studied the association between the duration of symptoms and outcome after surgery for lumbar disc herniation

Authors	Year of publication	Study design (level of quality)	Population size	Determination of symptom duration	Findings
Rihn et al. [13]	2011	Post hoc analysis of prospectively collected data (III)	1192	Early cohort (≤ 6 months) versus late cohort (> 6 months)	Patients with symptoms of ≤ 6 months had significantly improved SF-36 scores (in bodily pain and physical function domains [$p < 0.001$]) as well as ODI scores ($p < 0.001$)
Suzuki et al. [17]	2011	Retrospective case-control (III)	76	Continuous variable	Symptom duration did not impact motor weakness (OR, 1.02; 95% CI, 0.98–1.06; $p = 0.943$) or delay recovery (OR, 0.98; 95% CI, 0.92–1.04; $p = 0.554$)
Akagi et al. [1]	2010	Retrospective case-control (III)	46	Early cohort (< 3 months) versus late cohort (> 3 months [range, 3.2–18 months])	No significant difference ($p > 0.05$) in postoperative VAS scores or level of improvement after surgery; no significant difference in four subscales of the JOABPEQ Postoperative scores for psychological disorders significantly better in the late cohort ($p < 0.05$)
Blazhevski et al. [3]	2008	Prospective (II)	177	Three cohorts: 0–3 months, 4–10 months, > 10 months	Patients operated > 10 months after symptom onset had inferior outcomes (ODI) as compared with the 0- to 3-month and 4–10 month cohorts ($p < 0.001$); no difference was appreciated between the outcomes for 0- to 3- and 4- to 10-month groups
Ng and Sell [9]	2004	Retrospective case-control (III)	103	Four cohorts: < 2 months, 3–6 months, 7–12 months, > 12 months	Statistically significant difference ($p < 0.05$) in reduction of the mean ODI score of patients with symptom duration > 12 months as compared with the other groups
Gaetani et al. [5]	2004	Retrospective case-control (III)	430	Four cohorts: < 2 months, 3–6 months, 7–12 months, > 12 months	RC for the impact of symptom duration on degree of return to activities of daily living was 0.079 with $p = 0.0113$; patients receiving surgery within 3 months of onset were less likely to have severe limitation as opposed to those operated > 12 months ($p = 0.03$)
Fisher et al. [4]	2004	Prospective cohort (II)	82	Early cohort (< 3 months) versus 6.1–9 months, 9.1–12 months, and > 12 months	PDS significantly worse at 1 year ($p \leq 0.04$) and less improvement in PDS after surgery for all cohorts as compared with the group that received surgery within 3 months of symptom onset
Schoeggl et al. [14]	2002	Retrospective case-control (III)	258	Early cohort (< 3 months) versus late cohort (> 3 months)	Patients with symptoms > 3 months had significantly increased risk of developing failed back surgery syndrome ($p = 0.005$)
Nygaard et al. [10]	2000	Prospective cohort (II)	132	Four cohorts: < 4 months, 4–8 months, 8–12 months, > 12 months	Patients with symptoms < 4 months had significantly improved clinical outcome score as compared with those with symptoms > 8 months ($p < 0.05$)
Nygaard et al. [11]	1994	Retrospective case-control (III)	96	Early cohort (< 6 months) versus late cohort (> 6 months)	Patients with symptoms of < 6 months had significantly greater chance of chance of good postoperative outcome ($p = 0.01$)
Hurme and Alaranta [6]	1987	Prospective cohort (II)	357	Early cohort (< 2 months) versus late cohort (≥ 2 months)	Increased duration of symptoms had a negative impact on pain and working capacity ($p = 0.009$) and activities of daily living ($p = 0.005$) 6 months after surgery; patients who received surgery within 2 months had the best outcomes

ODI = Oswestry Disability Index; OR = odds ratio; CI = confidence interval; VAS = visual analog scale; JOABPEQ = Japanese Orthopaedic Association Back Pain Evaluation Questionnaire; RC = regression coefficient; PDS = pain/disability score.

Results

Does Symptomatic Duration Influence Outcomes After Lumbar Discectomy for Radiculopathy Caused by a Herniated Intervertebral Disc?

Of the 11 included investigations, nine concluded that symptomatic duration negatively influenced recovery after lumbar discectomy for radiculopathy (Table 1). However, there was substantial heterogeneity in terms of the way postoperative function and recovery were assessed. Five studies found that increased symptom duration had an adverse impact on function. Three studies made this determination using Oswestry Disability Index (ODI) scores and two based their conclusions on performance of activities of daily living. Three studies reported that increased symptomatic duration before discectomy led to less improvement in pain scores after surgery, whereas two documented less improvement in composite outcome scores. One investigation reported that increased duration of symptoms led to heightened risk of failed back syndrome.

All four prospective studies identified an association between symptom duration and recovery or function. Two works failed to find an association between symptom duration and postoperative recovery. One evaluated residual motor weakness and symptomatic improvement, whereas the other used a composite outcome score (Japanese Orthopaedic Association Back Pain Questionnaire). Both were small retrospective studies graded as level III quality. Based on the available evidence, we concluded that symptom duration does have a deleterious influence on outcomes after lumbar discectomy. This is a strong recommendation based on moderate-quality evidence.

What Is the Time Point for Surgical Intervention Beyond Which Postoperative Results Might Be Compromised?

Variability existed in terms of the time points for surgical intervention published in the collected works. Three studies identified 3 months of symptom duration as the critical time point beyond which postoperative recovery or function was compromised (Fig. 2). Two investigations reported 6 months as the critical threshold, whereas 2, 8, 10, and 12 months were proposed in separate studies. One of the studies that did not find an association between symptom duration and postsurgical function used a cutoff of 3 months, whereas the other analyzed time to surgery as a continuous variable. Among prospective studies, two documented time points of 8 and 10 months, respectively, whereas two others reported 2 and 3 months as the critical

juncture. If only investigations with a sample size exceeding 300 were considered, three studies met this criterion. One advocated for lumbar discectomy within 2 months of symptom onset, whereas two others supported intervention at 6 and 12 months after symptom onset. A preponderance of studies (five of nine) supported surgical intervention at a period of 6 months or greater after symptom onset, rendering this time point the most reasonable in light of the extant heterogeneity between works. This is a weak recommendation based on low-quality evidence.

Discussion

Lumbar discectomy for the treatment of radiculopathy caused by disc herniation is known to be an effective procedure. Although a number of studies have outlined the advantages of surgery over nonoperative care [2, 15, 18], it remains that most patients will improve with the latter. Reasonable practice recommendations endorse an algorithmic approach to management that begins with observation, physical therapy, and possibly epidural injections as the initial steps for treatment, reserving surgery for those who do not respond to these modalities [15]. The question that persists, however, is how long nonoperative care should be used before concluding that it has not been effective and therefore considering surgical options. Inherent in this question is the assumption that a prolonged period of preoperative symptoms can adversely influence clinical outcomes, which was explored in our systematic review. We identified 11 investigations that met inclusion criteria, nine of which maintained a negative association between symptomatic duration and postoperative pain, function, or neurologic recovery. Although heterogeneity between studies prevented a firm conclusion, a potential time point after which postsurgical recovery may be compromised by surgical delay appears to be 6 months after symptom onset.

As might be expected, several limitations in the existing literature inhibited our capacity to derive firm conclusions. There was substantial variability among investigations in terms of study design, measures of symptomatic duration, and postoperative recovery as well as overall quality. Few studies used similar time points and only a minority used validated functional outcome measures such as the ODI [3, 9, 13]. Furthermore, none of the works considered here evaluated severity of symptoms as a confounder or mediator of the effect of duration on recovery and heterogeneity between studies obviated our capacity to do so. This is an important limitation of the literature, because severity of patient symptoms may play a key role in determining surgical timing as well as the response to intervention.

Fig. 2 Graph depicting the number of studies supporting an association between duration and outcome after lumbar discectomy for radicular symptoms. Symptomatic duration is displayed along the x-

axis. The number of studies reporting an association for each time period is displayed along the y-axis.

In addition, many of the studies considered in this analysis were frankly retrospective or graded as level III quality as a result of their reliance on post hoc analyses (Table 1). Only six studies (55%) were specifically designed with the intent of investigating the influence of symptomatic duration on outcomes and none were prospective randomized trials. Of the four prospective investigations considered, only one enrolled more than 200 patients [6].

Consequently, within the existing literature, there is a substantial risk for confounding as a result of unappreciated biases. Some studies we evaluated, particularly two retrospective studies [1, 17] that reported no influence of symptom duration on outcome, may have been underpowered to detect differences. Within our review itself, the potential for publication bias is a paramount limitation. Variation among studies precluded formal statistical assessment of positive outcome bias using Harbord or Egger tests. Notwithstanding, the fact that nine of the 11 studies included in this analysis reported an association between symptom duration and degree of postoperative recovery is suggestive of a correlation.

In light of nine of 11 studies reporting an adverse effect for symptom duration on postsurgical pain or function, including all four prospective works, we conclude that the available evidence supporting this contention is fairly robust. As a result of variation between studies, however, it is more difficult to make a firm recommendation regarding the time point beyond which surgical results will be

compromised. Our determination regarding 6 months of symptom duration as a critical juncture was largely made based on the finding that five of nine studies reported that surgical interventions could be performed at periods of 6 months or greater without impacting results. This is clearly an area that warrants further work and one in which a multicenter prospective investigation with rigorous determinations of surgical time points and appropriate exclusion criteria would have an immediate impact on patient care.

Importantly, we seek to emphasize that length of symptom duration should not be seen as a reason to recommend against surgical intervention for any particular patient. Readers should recognize that although individuals receiving surgery at later time periods failed to achieve the same level of postoperative result as those who underwent early interventions, most studies support that lumbar discectomy confers a benefit regardless of the time point at which it is performed [9–11, 13]. Instead of being contradictory, these data are best applied to the preoperative discussion to forecast results for shared patient decision-making.

Based on the data from the studies in this review, we conclude that symptom duration very likely does have an adverse effect on pain and functional recovery after lumbar discectomy. A possible time point beyond which recovery may be compromised appears to be 6 months after symptom onset. As a result of limitations in the literature, the latter conclusion is admittedly weak and the issue of the

time period beyond which functional recovery may be diminished remains unresolved. Ultimately, a high-quality, prospective investigation will be necessary to definitively answer this question. Although a randomized trial around this issue is difficult to envision, a multicenter prospective study categorizing surgical candidates by length of symptomatic duration, while controlling for severity, seems a

real possibility and one that would make an invaluable contribution to the management of patients with lumbar radiculopathy.

Appendix

Investigations reviewed in full text that were ultimately excluded from the systematic review

First author	Journal (year of publication)	Title	Rationale for exclusion	Final conclusion
Tachibana	European Journal of Orthopaedic Surgery & Traumatology (2012)	Duration of sciatic for contained and noncontained lumbar disc herniation...	Influence of symptom duration on outcome was not reported	N/A
Lonne	European Spine Journal (2012)	Recovery of muscle strength after microdiscectomy for lumbar disc herniation...	Investigation included patients with acute motor paralysis	N/A
Haugen	BMC Musculoskeletal Disorders (2012)	Prognostic factors for non-success in patients with sciatica and disc herniation	Influence of symptom duration on outcome was not reported separately for surgical and nonsurgical cohorts	N/A
Moranjic	Acta Medica Saliniana (2010)	Outcome prediction in lumbar disc herniation surgery	Influence of symptom duration on outcome was not reported using p values and/or an effect size with 95% confidence intervals	Duration of pain symptoms was reported as strongly correlated with outcome
Peul	European Spine Journal (2009)	Timing of surgery for sciatica: subgroup analysis alongside a randomized trial	Influence of symptom duration on outcome was not reported separately for surgical and nonsurgical cohorts	N/A
Folman	Surgical Neurology (2008)	Late results of surgery for herniated lumbar disk as related to duration of preoperative symptoms and type of herniation.	Influence of symptom duration on outcome was not reported using p values and/or an effect size with 95% confidence intervals	Patients with preoperative pain duration of ≤ 6 weeks showed larger decrease in postoperative pain intensity than those with histories of 6–12 weeks
Jansson	Journal of Bone and Joint Surgery [British Volume] (2005)	Health-related quality of life in patients before and after surgery for a herniated lumbar disc	Influence of symptom duration on outcome was not reported using p values and/or an effect size with 95% confidence intervals	Patients with leg pain for < 6 months scored a mean of 0.08 higher postoperatively than those with longer symptomatic duration
Jonsson	Acta Orthopaedica Scandinavica (1993)	Patient-related factors predicting the outcome of decompressive surgery	Influence of symptom duration on outcome was not reported using p values and/or an effect size with 95% confidence intervals	Long preoperative duration of sciatica had a negative influence on 2-year outcome
Dvorak	Spine (1988)	The outcome of surgery for lumbar disc herniation...	Influence of symptom duration on outcome was not reported using p values and/or an effect size with 95% confidence intervals	N/A

N/A = not applicable.

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