Published in final edited form as:

PM R. 2016 May ; 8(5): 405–414. doi:10.1016/j.pmrj.2015.10.016.

Recurrence of Pain after Usual Non-Operative Care for Symptomatic Lumbar Disc Herniation: Analysis of Data from the Spine Patient Outcomes Research Trial

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Abstract

Objective—To determine risks and predictors of recurrent leg and low back pain (LBP) following unstructured, usual non-operative care for subacute/chronic symptomatic lumbar disc herniation (LDH).

Design—Secondary analysis of data from a concurrent randomized trial and observational cohort study.

Setting—13 outpatient spine practices.

Participants—199 participants with leg pain resolution and 142 participants with LBP resolution, from among 478 participants receiving usual non-operative care for symptomatic LDH.

Assessment of Risk Factors—Potential predictors of recurrence included time to initial symptom resolution, sociodemographics, clinical characteristics, work-related factors, imaging-detected herniation characteristics, and baseline pain bothersomeness.

Main Outcome Measurements—Leg pain and LBP bothersomeness were assessed using a 0 to 6 numerical scale at up to 4 years of follow-up. For individuals with initial resolution of leg pain, we defined recurrent leg pain as having leg pain, receiving lumbar epidural steroid injections, or undergoing lumbar surgery subsequent to initial leg pain resolution. We calculated cumulative

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risks of recurrence using Kaplan-Meier survival plots, and examined predictors of recurrence using Cox proportional hazards models. We used similar definitions for LBP recurrence.

Results—1- and 3-year cumulative recurrence risks were 23% and 51% for leg pain, and 28% and 70% for LBP, respectively. Early leg pain resolution did not predict future leg pain recurrence. Complete leg pain resolution (adjusted hazard ratio [aHR] 0.47, 95% confidence interval [CI] 0.31–0.72) and posterolateral herniation location (aHR 0.61 [95% CI 0.39–0.97]) predicted a lower risk of leg pain recurrence, and joint problems (aHR 1.89 [95% CI 1.16–3.05]) and smoking (aHR 1.81 [95% CI 1.07–3.05]) predicted a greater risk of leg pain recurrence. For participants with complete initial resolution of pain, recurrence risks at 1- and 3-years were 16% and 41% for leg pain, and 24% and 59% for LBP, respectively.

Conclusions—Recurrence of pain is common after unstructured, usual nonsurgical care for LDH. These risk estimates depend on the specific definitions applied, and the predictors identified require replication in future studies.

Keywords

herniation; sciatica; radiculopathy; intervertebral disk displacement; outcomes; lumbar; reherniation; relapse; recovery

INTRODUCTION

Symptomatic lumbar disk herniation (LDH) is a common cause of lumbosacral radicular pain and low back pain (LBP). Although many patients with symptomatic LDH improve without surgery [1–4], a question that often arises for those who experience resolution of pain is “Will my pain return?”. However, there are limited epidemiologic data regarding risks and predictors of pain recurrence with which to provide an informed answer to this question. Weber reported a 24% risk of ‘relapse’ within 4 years among patients receiving non-operative care for LDH, but did not describe the characteristics used to define either initial resolution or subsequent relapse, and did not examine factors predictive of relapse [1]. In a recent study of patients with resolution of symptoms after non-operative care for acute/subacute LDH (12 weeks), Suri et al. found that leg pain recurred in 25% of participants over 1-year follow-up, and LBP recurred in 43% [5]. A longer time to resolution of leg pain predicted a greater risk of subsequent leg pain recurrence, and older individuals were less likely to have LBP recurrence. All other studies of LDH recurrence to date have examined recurrence after surgery [6], leaving major gaps in our understanding of recurrence after non-operative care.

To have a true recurrence of pain, an individual must 1) experience *resolution* of the initial pain episode, and 2) subsequently experience a separate episode of the same type of pain (*recurrence*) [5, 7]. Estimates of pain prevalence at a time after the onset of pain do not measure true recurrence, since they also include individuals whose pain never resolved, and who therefore were never eligible to have a recurrence of pain [5, 8]. A general shortcoming in the literature on recurrence in spinal disorders such as LBP is that few studies clearly define resolution and recurrence, leading to potential inaccuracies in estimating recurrence, and making it difficult to compare recurrence estimates between different studies [7].

Survival analysis has been advocated as the optimal analytic approach for examining post-LDH resolution and recurrence due to the variable durations of follow-up inherent to studies of pain recurrence, but is rarely used for this purpose[9]. We conducted a secondary analysis of data from the Spine Patient Outcomes Research Trial (SPORT) to examine pain recurrence after unstructured, usual non-operative care for symptomatic LDH, using explicit definitions of pain resolution and recurrence, and survival analysis techniques. The purposes of this study were to identify 1) cumulative risks of recurrence of leg pain and LBP over 3-year follow-up, and 2) predictors of leg pain and LBP recurrence, in patients receiving usual non-operative care in SPORT.

METHODS

Study Participants

SPORT was conducted at 13 multidisciplinary spine practices throughout the United States, and was approved by the human subjects committees at each study site. Recruitment methods, data collection, and inclusion and exclusion criteria for the SPORT study of LDH are described in detail elsewhere[2, 3, 10, 11]. Briefly, participants were patients >18 years of age presenting with radicular pain of ≥ 6 weeks duration, and positive nerve root tension signs and/or neurologic deficits. All participants had MRI or CT imaging demonstrating a disc herniation corresponding with their clinical presentation. Exclusion criteria included cauda equina syndrome, progressive neurological deficits, malignancy, scoliosis, prior back surgery, and other contraindications to elective spine surgery. Eligible patients were offered participation either in a randomized trial (where operative management vs. usual non-operative care for LDH was randomly allocated by a computer), or in an observational cohort study (where operative management vs. usual non-operative care was chosen by the participant, advised by their treating physician). Due to high rates of crossover from assigned treatments, we conducted an analysis including all participants who were assigned to usual non-operative care as part of the randomized trial or who chose usual non-operative care as part of the cohort study. This usual non-operative care was unstructured, but could include education and counseling (92% of participants), physical therapy (43%), opioids (42%), non-steroidal anti-inflammatory medications (62%), or other treatments which were individualized according to the patient and the recommendations of their treating physician[12]. Usual non-operative care included epidural steroid injections (ESIs) for some patients (49%), but decision-making as to the appropriateness of ESI, relevant techniques, and the numbers of injections received were not standardized as part of this study[12].

Leg Pain and Low Back Pain Outcomes

Participants reported on leg pain bothersomeness and LBP bothersomeness over the past week during standardized evaluations conducted at baseline, 3 months, 1 year, 2 years, 3 years, and 4 years. Leg pain bothersomeness was rated using the leg pain item from the Sciatica Bothersomeness Index (SBI), a validated scale of sciatica-related symptom bothersomeness [13]. This item rates leg pain bothersomeness on a 7-point scale with scores ranging from 0 to 6, with lower scores indicating less severe leg pain bothersomeness. LBP bothersomeness was also rated using a 7-point scale with scores ranging from 0 to 6, with lower scores indicating less severe LBP bothersomeness. These items for leg pain and LBP

bothersomeness were previously used in the Maine Lumbar Spine Study[14] and the LAIDBACK study[15–17], and were included amongst the SPORT outcome measures to allow comparability with earlier work.

Defining Pain Resolution and Recurrence

This analysis included all consecutive SPORT participants who were assigned to usual non-operative care as part of the randomized trial, or who elected usual non-operative care as part of the observational cohort. These participants were classified as having ‘leg pain resolution’ if they reported dermatomal pain radiation and a leg pain bothersomeness score of 2 at baseline, and went on to have a leg pain bothersome score <2 with usual non-operative care during the first 3 years of follow-up. For this survival analysis, participants with leg pain resolution were followed prospectively from the time of leg pain resolution for any subsequent ‘leg pain recurrence’, defined as a leg pain bothersomeness score 2, receiving an epidural steroid injection, or undergoing lumbar spine surgery, at any time up to 3 years after the time of leg pain resolution. This definition of ‘recurrence’ aims to capture those individuals with increased leg pain symptoms occurring after initial leg pain resolution, or interventional procedures that would indicate that increased leg pain had occurred.

LBP resolution and recurrence were defined using similar methods. We identified the subgroup of participants with a LBP bothersomeness score of 2 at baseline, who went on to have LBP resolution with usual non-operative care, defined as a LBP bothersome score <2 during the first 3 years of follow-up. These participants were then followed prospectively from the time of LBP resolution for subsequent LBP recurrence at any time up to 3 years after the time of LBP resolution. Receiving an epidural steroid injection or lumbar spine surgery was not considered an endpoint for LBP recurrence, since these procedures are typically offered for treatment of lower extremity pain (not for LBP). Of note, the subgroups of participants experiencing leg pain resolution and LBP resolution were not distinct; that is, some individuals experienced resolution of *both* leg pain and LBP.

Potential Predictors of Recurrence

From among the many variables collected as part of the SPORT study, we chose a selected set of candidate variables that were analyzed as potential predictors of recurrence, based on conceptual importance or their prognostic value in prior studies of LDH[16, 18–22]. These potential predictors of recurrence are described below. Time to resolution of leg pain was our primary predictor of interest for leg pain recurrence, based on the results of Suri et al[5]. To examine time to resolution of leg pain, we defined those participants with ‘early leg pain resolution’ (within 6 months) as those who reported both 1) a symptom duration of 3 months prior to study recruitment, *and* 2) resolution of leg pain at 3-month follow-up. We examined baseline scores for leg pain bothersomeness and LBP bothersomeness as predictors of future recurrence, and whether ‘complete pain resolution’ (a pain bothersomeness rating of ‘0’ at the time of initial pain resolution) as compared to ‘near-complete pain resolution’ (a pain bothersomeness rating of ‘1’ at the time of initial pain resolution) would predict subsequent pain recurrence. Other potential predictors of recurrence included participant age, gender, race, educational attainment (at least some college vs. other), being married, body mass index (BMI [kg/m²]) smoking status (current,

past, or never), prior or current depression, prior joint problems (defined as rheumatoid arthritis, osteoarthritis, or other joint complaints in the hips, knees, shoulders, neck, hands, or elsewhere), or any other comorbidities selected from a list of medical conditions (hypertension, stroke, diabetes, osteoporosis, cancer, fibromyalgia, migraine, chronic fatigue syndrome, post-traumatic stress disorder, anxiety, alcohol or drug dependence, or other diseases of the heart, lung, liver, kidney, blood vessels, nervous system, stomach or bowel) [23]. Work-related potential predictors of recurrence included current employment (full-time/part-time vs. other), receiving any compensation (receiving or having applied for worker's compensation, Social Security compensation, or other compensation), and a rating of any lifting demands at work as 'important' or 'not important'. Expectations of the probability of being free of pain after usual non-operative care were measured using a 5-point Likert scale with the response options 'no chance', 'small chance', 'moderate chance', 'big chance', or 'certain (100%)'.

Other potential predictors of recurrence analyzed were imaging characteristics as assessed on baseline lumbar spine MRI or CT scans. Herniation location was classified as central, posterolateral, foraminal, or far lateral. Since the vast majority of herniations were posterolateral, herniation location was dichotomized as posterolateral vs. any other location. Herniation morphology was classified as a protrusion, extrusion, or sequestration. Herniation level was recorded as L2–L3, L3–L4, L4–L5, and L5–S1. Due to the low numbers of individuals with herniations at L2–L3 or L3–L4, these two levels were combined for analytic purposes.

Statistical Analysis

We identified the subgroups of individuals with initial resolution of leg pain only, initial resolution of LBP only, and initial resolution of both leg pain and LBP. We compared these three subgroups with respect to baseline characteristics, using the chi-square test for categorical variables and analysis of variance (ANOVA) for continuous variables. For those individuals with initial resolution of leg pain, we plotted Kaplan-Meier survival curves for leg pain recurrence. Censoring occurred at the first timepoint of missing leg pain bothersomeness outcome data for a participant, at study withdrawal, or at the end of the planned study follow-up. We calculated cumulative recurrence risks at 1-, 2- and 3-years, and the recurrence incidence density. We tested the proportional hazards assumption using cumulative sums of Martingale residuals and by visually inspecting Kaplan-Meier (KM) survival plots. We then used bivariate Cox proportional hazards regression models to examine associations between potential predictors of recurrence and recurrent leg pain up to 3-years of follow-up. We then examined multivariate associations between potential predictors of recurrence and recurrent leg pain using multivariate Cox proportional hazards regression with a stepwise variable selection procedure (entry $p < 0.10$, removal $p < 0.10$); age, gender, and early leg pain resolution (< 6 months) were forced into the multivariate models based on conceptual importance and other variables were selected based on significance. We calculated adjusted hazard ratios (aHR) and 95% confidence intervals (CI) for the association of each predictor variable with each recurrence event. We calculated the optimism-corrected Harrell's c -statistic using bootstrapping for the final multivariate model, in order to account for potential model overfitting[24]. We identified predictor variables with

95% CIs, with CIs not including unity reflecting statistical significance at $p < 0.05$. This analytic process was repeated for LBP recurrence, with age and gender forced into the multivariable models and other predictors selected based on significance. All analyses were performed using SAS software, version 9.3 (SAS Institute, Cary, NC).

RESULTS

Among 478 participants receiving conservative care as part of the randomized trial ($n=256$) or observational cohort ($n=222$), 217 participants had initial resolution of pain with usual non-operative care for symptomatic LDH, including 199 (42%) with resolution of leg pain, and 142 (30%) with resolution of LBP (Table 1). Of the 217 participants with pain resolution, there were 3 distinct subgroups: 75 participants with leg pain resolution only, 18 participants with LBP resolution only, and 124 participants with concurrent leg and LBP resolution. There were significant differences between the subgroups of participants with leg pain resolution, LBP resolution, and concurrent leg and LBP resolution with respect to baseline leg pain bothersomeness (mean $4.1 \pm$ standard deviation 1.3 vs. 1.9 ± 2.1 vs. 4.5 ± 1.4 respectively; $p < 0.001$), baseline back pain bothersomeness (2.4 ± 2.1 vs. 4.1 ± 1.6 vs. 4.0 ± 1.3 ; $p < 0.001$), and being married (83% vs. 72% vs. 66% respectively; $p = 0.04$). However, the subgroups were otherwise comparable with respect to baseline sociodemographic, work-related, clinical, and imaging factors (data not shown).

Figures 1 and 2 depict KM survival curves for leg pain recurrence and LBP recurrence. Recurrence events were clustered between approximately months 9 and 12 of each year due to the timing of the scheduled study follow-ups in relation to the time of initial pain resolution. The cumulative risk of leg pain recurrence was 23% at 1 year, 41% at 2 years, and 51% at 3 years. The cumulative risk of LBP recurrence was 28% at 1 year, 58% at 2 years, and 70% at 3 years. The average (range) years of follow-up was 1.91 (0.17–3.0) for leg pain recurrence and 1.71 (0.63–3.0) for LBP recurrence. The recurrence incidence density was 90 per 380.5 person-years for leg pain recurrence, and 89 per 243.3 person-years for LBP recurrence. In *post hoc* analyses, exclusion of patients who received epidural steroid injections prior to pain resolution did not result in any material differences in risks of leg pain or LBP recurrence (data not shown).

In bivariate analyses, early leg pain resolution was not a significant predictor of leg pain recurrence (Table 2). Complete leg pain resolution and posterolateral herniation location predicted a lower risk of leg pain recurrence in the bivariate analyses, and smoking and joint problems predicted a greater risk of leg pain recurrence. For the multivariate analysis examining predictors of leg pain recurrence, the independent variables of age, gender, early leg pain resolution, complete leg pain resolution, joint problems, smoking, and herniation location were retained in the final model (Table 2). In the multivariate analysis, early leg pain resolution was not a significant predictor of leg pain recurrence (aHR 1.27 [95% CI 0.80–2.02]). Complete leg pain resolution (aHR 0.47 [95% CI 0.31–0.72]) and posterolateral herniation location (aHR 0.61 [95% CI 0.39–0.97]) predicted a lower risk of recurrence, and joint problems (aHR 1.89 [95% CI 1.16–3.05]) and smoking (aHR 1.81 [95% CI 1.07–3.05]) predicted a greater risk of recurrence. The final multivariate model had an optimism-corrected Harrell's c -statistic of 0.71, indicating acceptable model discrimination.

In examining potential predictors of LBP recurrence, smoking status violated the proportional hazards assumption, indicating that this variable could not be appropriately analyzed using Cox proportional hazards regression (data not shown). Therefore, smoking was not analyzed as a predictor of LBP recurrence. In bivariate analyses, complete LBP resolution and other medical comorbidities predicted a lower risk of LBP recurrence, and joint problems predicted a greater risk of LBP recurrence (Table 3). For the multivariate analysis examining predictors of LBP recurrence, age, gender, complete LBP resolution, joint problems, and other medical comorbidities were retained in the final model (Table 3). In the multivariate analysis, complete LBP resolution (aHR 0.63 [95% CI 0.40–1.00]) and presence of other medical comorbidities (aHR 0.59 [95% CI 0.38–0.92]) predicted a lower risk of recurrence, and joint problems (aHR 1.89 [95% CI 1.16–3.053.05]) predicted a greater risk of recurrence. The final multivariate model had an optimism-corrected Harrell's c -statistic of 0.85, indicating excellent model discrimination.

Figures 3 and 4 depict the Kaplan-Meier survival curves for leg pain and LBP recurrence, stratified by complete pain resolution vs. near-complete pain resolution at the time of initial pain resolution. The cumulative incidence of subsequent leg pain recurrence in participants with complete pain resolution was 16% at 1 year, 28% at 2 years, and 41% at 3 years. The cumulative incidence of subsequent LBP recurrence in participants with complete pain resolution was 24% at 1 year, 46% at 2 years, and 59% at 3 years.

DISCUSSION

This study found a substantial cumulative risk of recurrent leg pain (23% and 51% at 1- and 3-year follow-up, respectively) and an even higher risk of recurrent LBP (28% and 70% at 1- and 3-year follow-up, respectively) in adults with initial resolution of pain after symptomatic LDH. Early leg pain resolution was not predictive of leg pain recurrence. Complete initial resolution of pain predicted a lower risk of both leg pain and LBP recurrence, and joint problems predicted a greater risk of both leg pain and LBP recurrence. Smoking predicted a greater risk of leg pain recurrence, posterolateral herniation location predicted a lower risk of leg pain recurrence, and other medical comorbidities predicted a lower risk of LBP recurrence. Cumulative risks of recurrent leg pain and LBP were considerably lower in the subgroup of participants who experienced complete initial resolution of pain, as compared to those with near-complete resolution of pain.

Estimates of recurrence risk in the current study are quite comparable with those from earlier reports. The 23% 1-year risk of leg pain recurrence in the current study is nearly equivalent to the 25% 1-year leg pain recurrence reported previously by Suri et. al [5]. Although the 28% 1-year risk of LBP recurrence in the current study is somewhat lower than the 43% 1-year LBP recurrence reported by Suri et. al, this is likely explained by the different definitions of resolution and durations of follow-up used in the two studies[5]. Our estimates for LBP recurrence after symptomatic LDH are considerably lower than earlier reports of recurrence after nonspecific LBP (with 1-year risks of recurrence between 66–84%[25]), but consistent with a more recent estimate (where 1-year recurrence was between 24–33%)[26]. Our finding that LBP recurrence is more common than leg pain recurrence is also consistent with the results of Suri et al, and with the general clinical wisdom that leg

pain improves more than LBP after LDH. Ultimately, all estimates of recurrence risk must be viewed in the context of a 'background rate' of incident pain symptoms that occurs irrespective of having a prior history of symptomatic LDH. Epidemiologic studies indicate that this background rate is considerable, with a 1-year incidence of radiating leg pain ranging from 6–10% [18, 27–29], and a generally higher 1-year incidence of LBP ranging from 3–36% [30–33]. This may explain in part why cumulative recurrence risks in the current study were quite high by the 3-year follow-up, and why recurrence risks were generally higher for LBP than for leg pain.

To our knowledge, only one prior study has examined predictors of recurrence after non-operative care for LDH using explicit definitions of resolution and recurrence [1]. Contrary to the results of Suri et. al [1], the current study did not find that having a shorter time to initial resolution of leg pain was protective against future leg pain recurrence, nor that older age predicted a lower risk of LBP recurrence. These conflicting findings may be due to differences between the study populations involved, since Suri et al. included only acute and subacute LDH patients (< 12 weeks), whereas SPORT also included chronic LDH patients. Other possible explanations include the different definitions for resolution and recurrence used in the two studies, and the fact that the composite variable we used to define 'early leg pain resolution' in this analysis only approximated time to resolution, which may have caused misclassification and potential bias.

In the current study, individuals who achieved a '0' pain bothersomeness rating on a 0 to 6 scale had roughly one half the risk of subsequent leg pain (aHR 0.47) and a substantially lower risk of LBP recurrence (aHR 0.60), as compared to individuals who achieved only a '1'. Although this is a novel finding, the idea that complete resolution of pain would have a more favorable prognosis than near-complete or partial resolution of pain appeals to common sense. Our findings suggest that patients with complete pain resolution may expect 1-year cumulative risks of pain recurrence which are comparable to or only slightly higher than the 'background rates' of 1-year incident leg pain and LBP mentioned above. Provided that our findings can be replicated, they may have an important clinical role in the counseling of LDH patients on their likelihood of future pain recurrence.

We found that smoking predicted a greater risk of leg pain recurrence, posterolateral (lateral recess) herniation location predicted a lower risk of leg pain recurrence, and that joint problems predicted a greater risk of both leg and LBP recurrence. These factors have been implicated as predictors of poor outcomes in LDH or LBP [19, 20, 34], though none had previously been examined specifically with respect to pain recurrence. We also found that the presence of other medical comorbidities (aside from self-reported depression or joint problems) *decreased* the risk of LBP recurrence. This finding is counterintuitive, and warrants further study.

There are limitations to our study worthy of mention. This was a secondary analysis of data, and the measures used to define recurrence in our study were not specifically designed for this purpose. Although the 7-point scales we used to measure leg pain and low back pain bothersomeness have been used in prior studies of sciatica and LBP [14–17], they have not undergone formal validation as stand-alone measures. Our analyses demonstrate that using

different cutpoints for defining pain resolution or pain recurrence can yield different risks for pain recurrence, and our estimates should therefore be viewed from that context. In addition, our definition for recurrence might more accurately be described as ‘the presence of elevated pain after a period of absent or minimal pain’, since individuals with complete or near-complete resolution were reassessed for pain bothersomeness over the preceding week at discrete timepoints separated by 9–12 months, rather than with more frequent assessments inquiring about any pain episodes which had occurred since the time of the last assessment. Given the sampling frame used, our recurrence estimates might have failed to capture recurrent symptoms that had quickly resolved within weeks to months without epidural steroid injections or surgery (that is, between the annual assessments). On the other hand, as previously mentioned, our recurrence definition may also have captured new leg pain or LBP episodes that were unrelated to the original presenting symptoms. In particular, the assessment of leg pain bothersomeness was not necessarily specific to sciatic pain only, and might have included other causes of new leg pain such as knee or hip osteoarthritis. This fact might in part explain why a past history of joint problems was associated with leg pain recurrence in our study (although it would not explain why joint problems were associated with LBP recurrence). Similarly, our assumption that post-resolution ESI or lumbar surgeries necessarily reflected recurrences of leg pain may have led to an overestimation of recurrence risks (since these procedures in practice can be performed for reasons other than leg pain alone). For these various reasons, future studies of pain recurrence after symptomatic LDH are required. Such studies may benefit from design considerations and measures intended to examine recurrence specifically, including more frequent follow-up assessments (to capture all recurrences) as well as follow-up clinical examinations incorporating specific steps to assist participants to discriminate true recurrences from distinct episodes of pain. Another potential limitation of our study was loss to follow-up, which we tried to account for by the use of survival analysis methods. Our study design had several methodologic strengths such as including only patients with known resolution in the group at risk for pain recurrence, using explicit definitions of resolution and recurrence in specific pain locations, and using patient-reported assessments of pain to define recurrence, rather than global assessments by the treating physicians. In addition, our multicenter sample drawing from 13 U.S. sites should provide some assurances as to the generalizability of our findings.

CONCLUSIONS

Recurrence is an important patient-reported outcome that has not been adequately studied in the context of usual non-operative care for LDH. Our study found a 23% and 51% risk of recurrent leg pain and a 28% and 70% risk of recurrent LBP at 1 and 3 years, respectively. Smoking predicted a greater risk of leg pain recurrence and posterolateral herniation location predicted a lower risk of leg pain recurrence. Complete resolution of pain and absence of joint problems predicted a lower risk of both recurrent leg pain and LBP. Other medical comorbidities were associated with lower risk of LBP recurrence. Possible study limitations including the specific definitions applied for recovery/recurrence, misclassification of recurrences, inadequate adjustment for confounding, and loss to follow-up warrant replication of these findings in future studies. Future research on the natural history and

prediction of recurrence is clearly needed to help assist in the clinical management of patients with these pain complaints.

Acknowledgments

The authors would like to acknowledge funding from the following sources:

The National Institute of Arthritis and Musculoskeletal and Skin Diseases (U01-AR45444) and the Office of Research on Women's Health, the National Institutes of Health, and the National Institute of Occupational Safety and Health, the Centers for Disease Control and Prevention. The Multidisciplinary Clinical Research Center in Musculoskeletal Diseases is funded by NIAMS (P60-AR048094 and P60-AR062799). Dr. Suri's participation in this study was funded by VA Puget Sound Health Care System. The authors report no financial arrangements that may represent a possible conflict of interest with the work presented.

The authors wish to thank the SPORT study participants and study staff for their time and effort.

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Figure 1.
Kaplan-Meier survival curve for leg pain recurrence.

Figure 2.
Kaplan-Meier survival curve for low back pain recurrence.

Figure 3.

Kaplan-Meier survival curve for leg pain recurrence, according to complete vs. near-complete pain resolution.

Figure 4.
Kaplan-Meier survival curve for low back pain recurrence, according to complete vs. near-complete low back pain resolution.
LBP=Low back pain

Table 1

Baseline characteristics of participants experiencing resolution of leg pain or back pain with usual non-operative care for lumbar disc herniation*

Baseline Characteristics	Leg pain resolution	Back pain resolution
	(n=199)	(n=142)
Early leg pain recovery (within 6 months) ^a	53 (27%)	-
Age (years)	44.6 (12.4)	43.8 (12.5)
Female	78 (39%)	53 (37%)
Race - White ^b	177 (89%)	123 (87%)
Education - At least some college	163 (82%)	112 (79%)
Married (vs. other)	144 (72%)	95 (67%)
Body Mass Index (kg/m2)	26.8 (4.6)	27.1 (4.6)
Smoking status		
Smoker	36 (18%)	24 (17%)
Used to	55 (28%)	35 (25%)
Never	108 (54%)	83 (58%)
Comorbidities		
Depression	20 (10%)	16 (11%)
Joint Problem	41 (21%)	28 (20%)
Other ^c	94 (47%)	60 (42%)
Employed full or part-time vs. other	142 (71%)	103 (73%)
Any compensation ^d	21 (11%)	20 (14%)
Important work lifting demands	99 (50%)	68 (48%)
High expectation of being free of pain with nonoperative treatment ^e	67 (34%)	53 (37%)
Baseline Leg Pain Bothersomeness (0–6) ^f	4.3 (1.4)	-
Baseline Back Pain Bothersomeness (0–6) ^g	-	4 (1.4)
Posterolateral herniation	150 (75%)	110 (77%)
Herniation Type		
Protrusion	62 (31%)	44 (31%)
Extrusion	119 (60%)	84 (59%)
Sequestration	17 (9%)	13 (9%)
Herniation Level		
L2–L3/L3–L4	22 (11%)	13 (9%)
L4–L5	76 (38%)	60 (42%)
L5-S1	100 (50%)	68 (48%)
** No ('0') leg pain bothersomeness at the time of leg pain resolution (vs '1')	117 (59%)	NA
** No ('0') LBP bothersomeness at the time of LBP resolution (vs '1')	NA	53 (37%)

* Values presented are means (standard deviations), or numbers (%)

^aLeg pain recovery was the primary predictor of interest

^bRace was self-assessed. Whites and blacks could be either Hispanic or non-Hispanic

^cOther medical problems related to stroke, diabetes, osteoporosis, cancer, fibromyalgia, chronic fatigue syndrome (CFS), post-traumatic stress disorder (PTSD), alcohol, drug dependence, heart, lung, liver, kidney, blood vessel, nervous system, hypertension, migraine, anxiety, stomach or bowel.

^dReceiving or applications pending for workers compensation, Social Security compensation, or other compensation.

^ePatient expectation of being free of pain with surgery was dichotomized as 'certain' or 'big chance' vs. 'no chance', 'small chance', or 'moderate chance'.

^fLeg Pain Bothersomeness Scale ranges from 0 to 6, with lower scores indicating less severe symptoms.

^gLow Back Pain Bothersomeness Scale ranges from 0 to 6, with lower scores indicating less severe symptoms.

Table 2

Leg pain: Associations between potential predictors and leg pain recurrence, for patients with initial resolution of leg pain with usual non-operative care for lumbar disc herniation

Potential predictors of recurrence	Bivariate Associations		Multivariate Associations*	
	Hazard Ratio (95% confidence interval)	P	Hazard Ratio (95% confidence interval)	P
Early leg pain recovery (within 6 months) ^a	1.26 (0.8, 1.97)	0.31	1.27 (0.80–2.02)	0.31
Age (years)	1.01 (0.99, 1.03)	0.17	1.01 (0.99–1.03)	0.36
Female	0.74 (0.48, 1.13)	0.16	0.73 (0.47–1.14)	0.17
Race - White ^b	0.77 (0.41, 1.46)	0.43	-	-
Education - At least some college	1.13 (0.64, 2)	0.67	-	-
Married (vs. other)	1.04 (0.65, 1.67)	0.86	-	-
Body Mass Index (kg/m2)	1.03 (0.98, 1.07)	0.25	-	-
Smoking status				
Smoker vs. Never	1.94 (1.17, 3.22)	0.01	1.81 (1.07–3.05)	0.03
Used to vs. Never	0.95 (0.57, 1.6)	0.86	0.88 (0.52–1.48)	0.62
Comorbidities				
Depression	1 (0.5, 2)	0.99	-	-
Joint Problem	2.18 (1.39, 3.44)	<0.001	1.89 (1.16–3.05)	0.01
Other ^c	1.08 (0.72, 1.64)	0.70	-	-
Full or part time employment (vs. other)	0.73 (0.46, 1.14)	0.16	-	-
Any compensation ^d	1.53 (0.85, 2.76)	0.16	-	-
Important work lifting demands	1.34 (0.88, 2.03)	0.18	-	-
High expectation of being free of pain with nonoperative treatment ^e	1.19 (0.77, 1.83)	0.44		
Baseline Leg Pain Bothersomeness (0–6) ^f	1.05 (0.9, 1.22)	0.57	-	-
No ('0') leg pain bothersomeness at the time of leg pain resolution (vs '1')	0.47 (0.31, 0.72)	<0.001	0.47 (0.31, 0.72)	<0.001
Posterolateral herniation	0.56 (0.35, 0.88)	0.01	0.61 (0.39–0.97)	0.04
Herniation Type				
Extrusion vs. Protrusion	0.74 (0.47, 1.16)	0.19	-	-
Sequestration vs. Protrusion	0.88 (0.41, 1.93)	0.76	-	-
Herniation Level				
L2–L3/L3–L4 vs. L4–L5	1.69 (0.89, 3.21)	0.11	-	-
L5–S1 vs. L4–L5	1.04 (0.66, 1.64)	0.86	-	-

Variables significant at p<0.05 in **bold**.

* potential predictors of recurrence which were retained in the final multivariate Cox proportional hazards regression model (using a stepwise variable selection procedure [entry p<0.10, removal p<0.10]); age, gender, and early leg pain resolution (<6 months) were forced into the model based on conceptual importance.

^a Leg pain recovery was the primary predictor of interest.

^b Race was self-assessed. Whites and blacks could be either Hispanic or non-Hispanic.

^c Other medical problems related to stroke, diabetes, osteoporosis, cancer, fibromyalgia, chronic fatigue syndrome (CFS), post-traumatic stress disorder (PTSD), alcohol, drug dependence, heart, lung, liver, kidney, blood vessel, nervous system, hypertension, migraine, anxiety, stomach or bowel.

^d Receiving or applications pending for workers compensation, Social Security compensation, or other compensation.

^e Patient expectation of being free of pain with surgery was dichotomized as 'certain' or 'big chance' vs. 'no chance', 'small chance', or 'moderate chance'.

^f Leg Pain Bothersomeness Scale ranges from 0 to 6, with lower scores indicating less severe symptoms.

Table 3

Low back pain: Associations between potential predictors and low back pain recurrence, for patients with initial resolution of low back pain with usual non-operative care for lumbar disc herniation

Potential predictors of recurrence ^a	Bivariate Associations		Multivariate Associations [*]	
	Hazard Ratio (95% Confidence Interval)	P	Hazard Ratio (95% Confidence Interval)	P
Age (years)	1 (0.98, 1.02)	0.88	1 (0.98–1.02)	0.79
Female	0.96 (0.63, 1.48)	0.87	0.99 (0.64–1.52)	0.95
Race - White ^b	0.7 (0.4, 1.22)	0.21	-	-
Education - At least some college	0.91 (0.54, 1.52)	0.71	-	-
Married (vs. other)	1.1 (0.71, 1.72)	0.67	-	-
Body Mass Index (kg/m2)	1.01 (0.96, 1.06)	0.62	-	-
Comorbidities				
Depression	0.99 (0.51, 1.91)	0.97	-	-
Joint Problem	1.69 (1.06, 2.69)	0.03	1.82 (1.11–2.98)	0.02
Other ^c	0.59 (0.38, 0.92)	0.02	0.59 (0.38, 0.92)	0.02
Full or part time employment (vs. other)	0.85 (0.53, 1.37)	0.51	-	-
Any compensation ^d	1.01 (0.55, 1.86)	0.97	-	-
Important work lifting demands	0.87 (0.58, 1.33)	0.53	-	-
High expectation of being free of pain with nonoperative treatment ^e	1.06 (0.7, 1.62)	0.77	-	-
Baseline Low Back Pain Bothersomeness (0–6) ^f	0.93 (0.8, 1.1)	0.41	-	-
No ('0') LBP bothersomeness at the time of LBP resolution (vs '1')	0.63 (0.4, 0.99)	0.05	0.63 (0.4–1.00)	0.05
Posterolateral herniation	0.68 (0.42, 1.08)	0.10	-	-
Herniation Type				
Extrusion vs. Protrusion	0.98 (0.62, 1.55)	0.93	-	-
Sequestration vs. Protrusion	0.58 (0.24, 1.4)	0.22	-	-
Herniation Level				
L2–L3/L3–L4 vs. L4–L5	0.99 (0.48, 2.03)	0.97	-	-
L5–S1 vs. L4–L5	0.85 (0.55, 1.32)	0.48	-	-

Variables significant at $p < 0.05$ in bold.

^{*} Potential predictors of recurrence which were retained in the final multivariate Cox proportional hazards regression model (using a stepwise variable selection procedure [entry $p < 0.10$, removal $p < 0.10$]); age and gender were forced into the model based on conceptual importance.

^a Smoking status violated the proportional hazards assumption and was not included in the proportional hazards models for low back pain recurrence.

^b Race was self-assessed. Whites and blacks could be either Hispanic or non-Hispanic

^c Other medical problems related to stroke, diabetes, osteoporosis, cancer, fibromyalgia, chronic fatigue syndrome (CFS), post-traumatic stress disorder (PTSD), alcohol, drug dependence, heart, lung, liver, kidney, blood vessel, nervous system, hypertension

^d Receiving or applications pending for workers compensation, Social Security compensation, or other compensation.

^ePatient expectation of being free of pain with surgery was dichotomized as 'certain' or 'big chance' vs. 'no chance', 'small chance', or 'moderate chance'.

^fLow Back Pain Bothersomeness Scale ranges from 0 to 6, with lower scores indicating less severe symptoms.

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