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ORIGINAL ARTICLE

# Risk factors for the need of surgical treatment of a first recurrent lumbar disc herniation

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**Abstract**
*Purpose* A recurrent lumbar disc herniation (RLDH) is the most prevalent cause for new radicular pain after surgery for disc herniation-induced sciatica. Reported risk factors include age, gender and smoking, while its surgical treatment is associated to a higher rate of complications and costs. The purpose of this study is to identify factors that increase the risk of requiring surgical treatment for a first RLDH in workers' compensation patients.
*Methods* Nested case–control: 109 patients operated for an RLDH (cases) between June 1st 1994 and May 31st 2011 (minimum follow-up 1 year) and 109 randomly selected patients operated for a first disc herniation with no recurrence during the study period (controls). Age, gender, smoking status, type of work and MRI characteristics of the index herniation were statistically evaluated as potential risk factors.
*Results* Patient's age of less than 35 years ($p = 0.001$) and a subligamentous herniation ($p < 0.05$) at the time of the index surgery were identified as risk factors for requiring surgical treatment of a first RLDH. No statistical differences were observed between both groups regarding the other evaluated variables.
*Conclusion* A subligamentous disc herniation and patient's age inferior to 35 years at the time of the first surgery are risk factors for requiring surgical treatment of a first RLDH among workers' compensation patients.

**Keywords** Recurrent lumbar disc herniation · Surgery · Risk factors

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## Introduction

Although lumbar discectomy presents good results in the majority of patients operated for a lumbar disc herniation (LDH) [1–4], up to 30 % can evolve with unsatisfactory outcomes [5–7], mainly in the form of persistent or recurrent radicular pain. Several etiologies have been described, including recurrent lumbar disc herniation (RLDH), an LDH in another level, scar tissue, arachnoiditis, foraminal stenosis, segmental instability and spondylitis/spondylodiscitis [6, 8, 9]. RLDH is the most prevalent one, with a reported incidence between 2 and 18 % [5, 6, 10–13].

An RLDH is defined as the presence of new material in the spinal canal, originated from a previously operated disc, either on the same or the contralateral side, with a pain-free period of at least 6 months after the index discectomy [6]. The gold standard diagnostic test is a gadolinium-enhanced MRI, which allows differentiation between scar tissue (enhanced), from recurrent disc herniation (not enhanced or only peripherally enhanced) [8, 9].

Surgery-induced microinstability, together with an incomplete discectomy and the presence of a portal at the annulus could facilitate recurrent herniation [14]. Multiple risk factors for RLDH have been reported, including age, gender, smoking, body mass index (BMI), disc degeneration, trauma, occupational lifting, characteristics of the original disc herniation and aggressiveness of the index discectomy [6, 9, 12, 14–17].

Overall, treatment of an RLDH does not differ greatly from that of a first LDH, achieving good results in a high percentage of patients with conservative treatment. In those patients with no response or those who fulfill surgical indications (same criteria as with a first LDH), a new discectomy is indicated. Although the outcomes of this technically more demanding [8] second procedure are comparable to those of the index surgery in general population [9], it has been associated to increased morbidity [18, 19] and higher costs [20].

The purpose of this study is to identify factors associated to a higher risk of presenting an RLDH requiring surgical treatment among patients under a workers' compensation program.

## Methods

### Patient selection

After approval from the Ethics Committee, we conducted a retrospective nested case–control study at our medical institution, the main administrator of our country's workers' compensation program, covering over 50 % of the total affiliated workforce.

We identified all the patients operated for a single-level LDH and/or for a first RLDH between June 1st, 1994 and May 31st, 2011 (17-year study period, minimum 1 year of postoperative follow-up). We excluded those patients who had their index surgery done in another institution and those who presented a pain-free period of less than 6 months after their primary discectomy. We added up a total of 1106 surgeries, performed on 1028 patients, including 109 patients operated for a gadolinium-enhanced MRI-certified first RLDH (cases). The 919 patients operated for an LDH, with no RLDH during the study period were gathered in a correlative list with their ascending medical record number and, using an online random number generator (http://www.random.org, accessed on July 1st, 2012), 109 of these patients were selected as controls. As we wanted to include multiple variables in our risk factor analysis, no matching among the cases and controls was performed.

Data collected and analyzed as possible risk factors included demographics, characteristics of the index LDH and perioperative information. Among demographics, we recorded age, gender, smoking status (yes or no) and type of work (light or heavy). Regarding MRI and/or intraoperative characteristics of the index LDH, we identified level, axial (central, posterolateral or lateral) and sagittal location (at disc level, cranially or caudally migrated), type of herniation (extrusion or protrusion) and relationship with the posterior longitudinal ligament (PLL): subligamentous or transligamentous [21] (Fig. 1). Finally, surgery duration, perioperative complications, length of stay (LOS), time out of work and follow-up since the index surgery were also recorded.

### Surgical technique

A loupe-assisted posterior lumbar microdiscectomy was performed in every case by one of the members of our Spine Surgery Unit for the first LDH, including prophylactic antibiotics before the incision, a unilateral laminotomy of both levels on the symptomatic side, together with an aggressive discectomy and repeated disc space irrigation to release remaining disc fragments. A bilateral approach was performed in patients with bilateral disc herniations and in some of those with big central disc herniations. Local instillation of steroids was indicated as per the surgeon's judgment.

Patients with persistent or recurrent radicular pain after discectomy for LDH were studied with both a gadolinium-enhanced MRI (to differentiate scar tissue from new disc material, Fig. 1) as well as flexion–extension X-rays (to assess stability at the previously operated segment). None of the patients included in the cases group presented instability, either in preoperative imaging or during the revision surgery, so only a new discectomy was performed in all of them, paying special attention to the potentially altered anatomy due to the previous procedure.

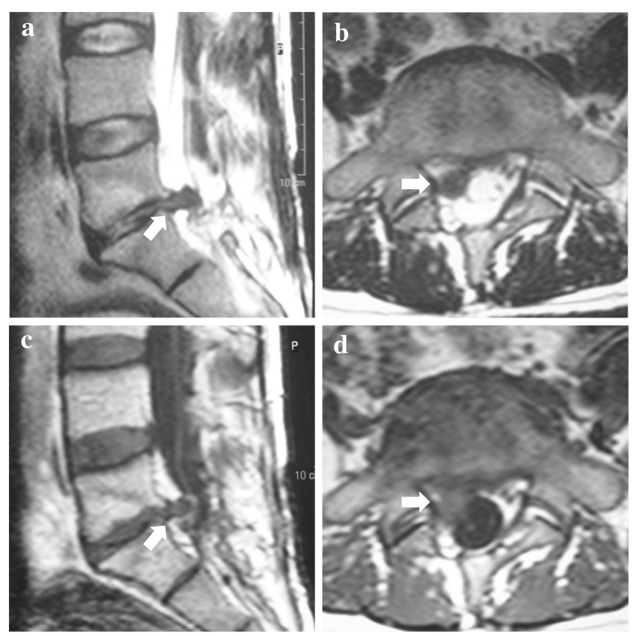


**Fig. 1** MRI images of a 45-year-old male patient who presented a right-sided L5–S1 RLDH (*white arrows*) 25 months after the index surgery for the original same-sided LDH [T2 axial (**a**) and sagittal (**b**), contrast-enhanced axial (**c**) and sagittal (**d**)]

### Statistical analysis

Using an electronic spreadsheet (Microsoft® Excel 2011 for Mac, Redmond, WA), the data were statistically analyzed to identify possible risks factors. The incidence of RLDH requiring surgical treatment during the study period was calculated. The Chi-square test or the Fisher's exact test with odds ratios (OR) were used to compare frequencies (age as categorical variable, gender, type of work, smoking status, characteristics of the index LDH and perioperative complications) and the Student $t$ test was used to compare means (age, surgery duration, LOS, time out of work and follow-up since index surgery). A $p$ value $<0.05$ was considered as statistically significant.

## Results

The 1106 surgeries (1028 patients) either for LDH or RDLH identified during the study period can be divided into the following:

919 patients (89.4 %) operated for an LDH, who did not present a symptomatic RLDH or if they did, it responded to conservative treatment.

109 patients (10.6 %) operated for a first RLDH (cases), which can be further divided into two groups:

- 31 patients (28.4 %) whose index surgery was performed before June 1st 1994, but were operated for the RLDH during the study period.
- 78 patients (71.6 %) operated for both the index LDH and the RLDH during the study period.

The incidence for RLDH requiring surgical treatment during the study period (17 years) was 7.8 % [patients operated for both the index LDH and the RLDH during the study period/total patients operated for their first LDH during the study period × 100 = 78/(919 + 78) × 100].

### Demographic data (Table 1)

A statistically significant difference was observed for the age of the patients at the time of the index discectomy. The mean ± standard deviation (SD) age was 35.1 ± 7.5 years

**Table 1** Summary of demographic data

| Variable | Cases | Controls | $p$ |
|---|---|---|---|
| Age (years)[a] | 35.1 ± 7.5 | 40.4 ± 8.9 | <0.05 |
| Gender: female/male (%) | 2.8/97.2 | 9.2/90.8 | 0.08 |
| Smoking status: yes/no (%) | 32/68 | 40.8/59.2 | 0.19 |
| Type of work: light/heavy (%) | 13.8/86.2 | 17.4/82.6 | 0.46 |

[a] Mean ± standard deviation

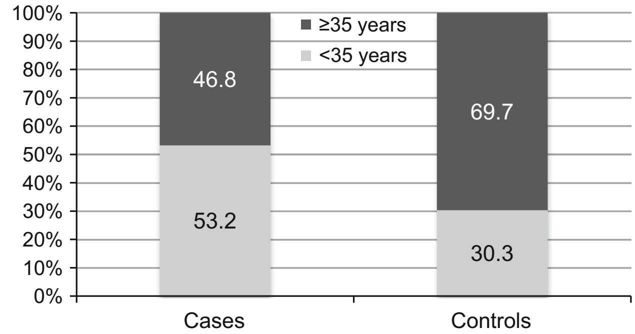


**Fig. 2** Age distribution according to the 35 years' cutoff point

for the cases and 40.4 ± 8.9 for the controls ($p < 0.05$). We further analyzed this item by transforming it into a categorical variable using the mean age of the cases as a cutoff point: younger than 35 and 35 years or older (Fig. 2). The cases group presented 53.2 % of patients under 35 years, compared to 30.3 % in the control group. The statistical difference was confirmed with the Chi-square test: $p = 0.001$, OR 2.62 (95 % CI 1.45–4.75).

Regarding gender, the cases presented a slightly higher proportion of males (97.2 versus 90.8 %), but this difference did not reach statistical significance ($p = 0.08$, OR 3.57, 95 % CI 0.87–16.88).

There were no significant differences in terms of smokers (32 versus 40.8 %, $p = 0.19$) and heavy workers (86.2 versus 82.6 %, $p = 0.46$).

### MRI and intraoperative characteristics of the index LDH (Table 2; Fig. 3)

The LDH level distribution was similar in both groups ($p = 0.11$), with L5–S1 as the most frequent one (cases: 64.2 %, controls: 56 %). The most common location in both groups was posterolateral for the axial plane (cases: 89.7 %, controls: 82.6 %) and disc level for the sagittal plane (cases: 79.6 %, controls: 78 %), with no statistical differences ($p = 0.26$ and 0.36, respectively). The extrusion was the most observed type of LDH in both groups (cases: 81.9 %, controls: 78.5 %, $p = 0.55$). Finally, the relationship with the PLL was the only characteristic with a statistically significant difference between the two groups, as the cases presented a higher frequency of subligamentous herniations (92.6 versus 72.6 %, $p < 0.05$, OR 4.74, 95 % CI 1.75–13.34).

### Perioperative data (Table 3)

Both groups had comparable mean surgery duration (cases = 85.3 min, controls = 88.6 min, $p = 0.47$), LOS (4.5 versus 3.7 days, $p = 0.08$) and time out of work after the surgery for the index LDH (66.6 versus 61.3 days, $p = 0.27$).

Regarding the surgery-related complications of the index procedure, two incidental dural tears occurred among the cases and four in the control group, all of these lesions were diagnosed and treated intraoperatively, and none of these patients required new procedures due to them. One of the controls, operated for an L3–L4 left-sided lateral LDH presented a pars fracture and evolved with persistent low back pain, which required an instrumented fusion. Although we observed a higher incidence of complications in the control group (4.6 versus 1.8 %), this was not statistically significant ($p = 0.45$).

**Table 2** MRI and intraoperative characteristics of the index LDH

| Variable | Cases | Controls | *p* |
|---|---|---|---|
| Level (%) | | | 0.11 |
| L3–L4 | 0.9 | 5.5 | |
| L4–L5 | 34.9 | 38.5 | |
| L5–S1 | 64.2 | 56 | |
| Axial location (%) | | | 0.26 |
| Central | 5.6 | 7.3 | |
| Posterolateral | 89.7 | 82.6 | |
| Lateral | 4.7 | 10.1 | |
| Sagittal location (%) | | | 0.36 |
| Migrated cranially | 7.1 | 3.7 | |
| Disc level | 79.6 | 78 | |
| Migrated caudally | 13.3 | 18.3 | |
| Type (%) | | | 0.55 |
| Protrusion | 18.1 | 21.5 | |
| Extrusion | 81.9 | 78.5 | |
| Relationship with the PLL (%) | | | <0.05 |
| Subligamentous | 92.6 | 72.6 | |
| Transligamentous | 7.4 | 27.4 | |

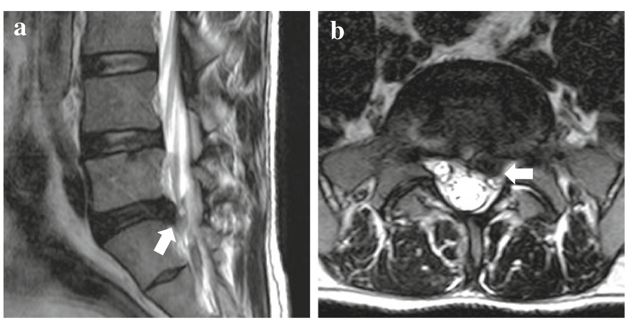


**Fig. 3** T2 sagittal (**a**) and axial (**b**) MRI images of a 33-year-old male patient with a left-sided L5–S1 subligamentous LDH (*white arrows*) included in the cases group

The follow-up since the index surgery was statistically longer for the cases (16 versus 12.8 years, $p < 0.05$). This could be explained by the fact that 28.4 % of the RDLH cases had their index procedure done before the study period.

## Discussion

We conducted a retrospective case/control study to identify risk factors for presenting an RLDH requiring surgical treatment among patients under a workers' compensation program. We calculated a 7.8 % incidence of symptomatic RLDH, which required surgical treatment during the 17-year study period. This value is within the range of previous reports in general population [5, 6, 10–12]. In a systematic review from 2009, McGirt et al. [5] reported an RLDH incidence of 7 % for limited discectomy and 3.5 % for aggressive discectomy. The same authors reported an RLDH incidence of 10.2 % in a prospective cohort of 100 patients [12]. Using retrospective data, Kim et al. [6] described an incidence of RLDH of 16.4 % among a group of 171 patients operated for an L4–L5 LDH during a 3-year period. Applying Kaplan–Meier analysis to data from 186 patients, Aizawa et al. [10] established a 5.9 % reoperation rate for RLDH 17 years after the primary discectomy, while Jansson et al. reported a 10-year re-operation rate of 10 % after analyzing retrospective data from 22,261 patients operated for an LDH in Sweden between 1987 and 1999 [11].

Multiple risk factors for RLDH have been described [6, 9, 12, 14–17], including demographics (patients' age,

**Table 3** Summary of perioperative data

| Variable | Cases | Controls | *p* |
|---|---|---|---|
| Surgery duration (min)[a] | 85.3 ± 31.7 | 88.6 ± 34.6 | 0.47 |
| Complications (no. to %)[b] | 2–1.8 % | 5–4.6 % | 0.45 |
| Length of stay (days)[a] | 4.5 ± 3.5 | 3.7 ± 3 | 0.08 |
| Time out of work (days)[a] | 66.6 ± 40 | 61.3 ± 30 | 0.27 |
| Follow-up since index surgery (years)[c] | 16 (2.7–30.2) | 12.8 (2.5–18.2) | <0.05 |

[a] Mean ± standard deviation

[b] Cases: 2 durotomies/controls: 4 durotomies and 1 pars fracture

[c] Median (range)

gender, smoking status, BMI and type of work), characteristics of the original LDH (size, location and relationship with PLL), local degenerative changes and features of the initial surgery (type of approach, volume of removed disc, size of the annulus defect and its closure).

Cinotti et al. [14] reported that male patients with severe disc degeneration and an identifiable traumatic triggering event for the recurrent radicular pain presented a higher risk of RLDH. Suk et al. [9] also described male gender and traumatic events as risk factors for recurrent herniation, together with young age and smoking. Carragee et al. [15] focused on intraoperative findings, identifying a correlation between the competence of the annulus after the primary discectomy and the type of herniation with the RLDH rate. Kim et al. [16] reported that older age, obesity and positive Modic changes [22] were associated to a higher risk of recurrent herniation after a percutaneous endoscopic discectomy. Kim et al. [6] also identified smoking and disc degeneration as risk factors, but they additionally established a correlation between the preoperative biomechanical condition of the spine (by measuring segmental motion and disc height) and the incidence of RDLH. McGirt et al. [12] reported that larger annular defects and less disc removal increased the risk of recurrent herniation. Finally, in a study by Miwa et al. [17], smoking was once again mentioned, adding occupational lifting as another risk factor.

Regarding our study, we evaluated demographic data, characteristics of the index LDH and perioperative information. Using univariate analysis, we confirmed one of the previously reported risk factors in general population (young age), but we also add a new element to be considered: subligamentous location of the index LDH. This could also be related with the age of our cases. Younger patients should present milder degrees of degenerative disc disease (DDD), so their discs should be taller and their annulus more competent compared to those of older patients, explaining a higher frequency of subligamentous primary disc herniations. This fact could also address the higher incidence of RLDH among younger male patients, as taller discs contain more disc material that could reherniate during their potentially longer postoperative period, compared with older patients with more collapsed discs. This is particularly important in our population, as it is predominantly conformed by heavy-working young males, but we were not able to confirm these associations in our study group. We only identified a tendency for a higher risk of RLDH among male patients ($p = 0.08$), but we could not establish an association between heavy workers and RLDH. The same thing occurred with smokers; in fact, our control group presented a higher percentage of smokers (40.8 versus 32 %, $p = 0.19$).

Although we hope that our findings can be useful to further understand risk factors for RLDH, we must also recognize the inherent weaknesses that this study presents and that must be considered when interpreting these results and discussion. First of all, only compensated patients were included, so the described findings not necessarily apply to general population. It is a retrospective study, based on the revision of medical records, so there is potential bias due to incomplete charts or misinterpretation of transcribed data particularly from handwritten older charts. We did not had access to all of the MRI images, which was compensated with the review of the radiologist's report, the surgeon's interpretation of the images and the intraoperative findings, but this practice could also be affected by the previously described bias. Finally, we used a randomly selected control group of the same size of the cases group. We look forward to designing new research projects addressing these issues, ideally with prospectively collected data. Given the widespread recognition of the genetic influence in DDD [23], it is also necessary to consider family history of RLDH or multiple spine surgeries, along with the previously reported factors.

## Conclusion

A subligamentous index LDH and age under 35 years at the time of the first discectomy were identified as risk factors for presenting an RLDH requiring surgical treatment among patients under a workers' compensation program.

**Compliance with ethical standards**

**Conflict of interest** None.

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