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Recurrence of lumbar disk herniation after microdiscectomy: a two-center retrospective analysis of 1214 cases and identification of risk factors

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Background/aim: To present the incidence of recurrent lumbar disc herniation (RLDH) and to identify radiological and patient-related risk factors that lead to recurrence after lumbar disc herniation (LDH) treatment with microdiscectomy.
Materials and methods: Between January 2013 and December 2021, 1214 patients who had undergone microdiscectomy for LDH were included in this retrospective study. Patients were divided into two groups, the recurrent group and the non-recurrent group, and their demographic, clinical and radiologic characteristics were recorded. The association between the variables and RLDH was assessed by univariate and multivariable logistic regression analyses.
Results: Mean ages were similar in the recurrent (51.48 ± 13.63) and non-recurrent(50.38 ± 14.53) groups (p=0.232). Males represented 59.6% of the recurrent group and49.8% of the non-recurrent group (p=0.002). Multivariable logistic regression revealedthat being a male (p=0.009), diabetes mellitus (p=0.038), smoking (p<0.001), grade 4&5disc degeneration (p<0.001), and having protruded (p=0.002), extruded LDH (p<0.001),paracentral (p=0.008) and foraminal LDH (p=0.008) were independently associated withrecurrence.
Conclusion: To reduce RLDH frequency and need for revision surgery, modifiable riskfactors should be minimized before and after the initial surgery. Also, in patients withunmodifiable risk factors, patients should be clearly informed about the risk forrecurrence and possible alternative treatment methods should be considered.

Keywords: Recurrent lumbar disc herniation, microdiscectomy, risk factors, thePfirrmann grading system

1. Introduction

Lumbar disc herniation (LDH) is the most common cause of low back pain, leg pain andwork loss related with them [1,2]. While 90% of patients with LDH can be treatedconservatively, 10% require surgical treatment [3,4]. Compared to conservativetreatment, surgery allows faster and more effective pain relief, and prevents progressionof motor deficits due to LDH [5]. However, recurrence and reoperation are among thecommon outcomes of surgery, and complications such as such as hematoma, infection,dural injury and nerve root injury have been reported [4,6,7].

Despite advances in surgical techniques, postoperative LDH recurrence continues todemonstrate a high rate, ranging from 0.5% to 25% [4,6]. Recurrent LDH (RLDH) increases risks for debilitating pain, disability, resurgery and additional burden on thehealthcare system [8]. Unfortunately, the rate of reoperation due to RLDH varies between3% and 11% and there are studies showing that revision spine surgeries have pooroutcomes and a higher complication likelihood compared to primary surgery [2,9,10].

Because of its high rate and the mentioned adversities that arise from it, many researchershave turned to investigating risk factors that lead to RLDH in order to reduce itsincidence. The most commonly reported ones may classified as follows: Patient-relatedfactors: Age [11,12], sex [13,14,15], body-mass index (BMI) [16,17], diabetes mellitus(DM) [5,16], smoking [2,18] and hereditary factors such as biomechanical [3] andanatomical differences (lumbosacral transitional vertebra [4] and intervertebral discspace[5,16]); Pre-surgical radiological risk factors: Modic changes [5,16], Pfirrmanngrade [19,20], type [18,21] and location [22,23] of disc herniation [20];

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Surgical riskfactors: Surgeon experience [22] and type of primary surgery [21,24]; Post-surgical riskfactors: High-intensity postoperative activity [13,25] and occupation [18]. Although there are many studies on the subject, most of the related studies have either a small number of participants [16,19,20] or a small number of parameters investigated [2,24], or both[1,7,13,18].

In this study, we aimed to present the incidence of RLDH and to determine radiologicaland patient-related risk factors that are associated with post-surgical RLDH in patientswho underwent microdiscectomy for LDH, with the inclusion of a large number ofparameters and a large number of participants.

2. Patients and methods2.1Study design and ethical issues

This retrospective study was carried out by inclusion of patients from two Neurosurgerydepartments, Lokman Hekim University Hospital, Ankara, Turkey and Medical ParkGaziantep Hospital, Gaziantep, Turkey. Ethical approval for this study was provided bythe Research Ethics Committee of the Faculty of Medicine of Lokman Hekim University(Date:29.03.2022 number:2022-58). It was carried out in accordance with the ethicalstandards set forth in the 1964 Declaration of Helsinki and its amendments.

2.2. Study population and data collection

A total of 1214 patients who underwent open-approach microdiscectomy for LDH in thetwo hospitals, from January 2013 to December 2021, were included in the study. Amongthese, 327 (26.9%) had developed RLDH (recurrent group), while the rest did not haverecurrence (non-recurrent). To be eligible for inclusion in the study, patients had to meetthe following criteria: 1) be between 18 and 70 years old, 2) have recurrent low back painwith radiculopathy at least 6 months after primary lumbar disc surgery, 3) have recurrentradicular pain unresponsive to conservative treatment for at least 6 weeks, 4) haverecurrent low back pain with progressive neurological deficits 6 months after surgery, and5) have magnetic resonance imaging of the lumbosacral spine showing disc herniation atthe same level as the primary discectomy. Patients who developed RLDH within the first6 months after the index surgery, those whose symptoms persisted after surgery, thosewith serious surgical or post-surgical complications, patients treated through endoscopicdiscectomy, patients with RLDH at a different level/side compared to before the indexsurgery, those with a history of LDH surgery at another center before the index operation,cases with less than 12 months follow-up period after index surgery, those with spinalinstability, and patients with low back pain without leg pain were excluded from thestudy.All demographic data including age and sex, anthropometric data including BMI (kg/m^2),clinical data including comorbidities, smoking status, and all disease-related datadetermined by magnetic resonance (MR) imaging before the initial surgery [includinglevel, side (right or left), type and location of disc herniation and degree of discdegeneration (Pfirrmann grade)] [26] were obtained.

All relevant data and recurrence-related features were retrospectively recorded via use of the hospitals' computerdatabases. Recorded MR images were evaluated by an experienced radiologist. Patientswhose recent information could not be reached from hospital records or those who didnot attend follow-up were contacted by phone to obtain information about their recentstatus. In order to determine RLDH in these contacted patients (some of which stated thatthey undergone re-operation in other hospitals), the hospitals were called by phone and 94necessary information was obtained from the operating physician. Participants who could not be reached were excluded from the study.

2.3. Definitions and tools

2.3.1 Recurrent lumbar disc herniation

Recurrent lumbar disc herniation was defined as confirmation of disc herniation at thesame level and side as the primary LDH by MR imaging, after more than 6 months ofpain-free and untreated interval from the index operation [27].

2.3.2 The Pfirrmann grading system

Lumbar disc degeneration classification was performed by experienced radiologists usingT2-weighted MR images according to The Pfirrmann grading system (PGS) (26). PGS isa system that divides the extend of lumbar disc degeneration into 5 grades according tothese 4 features: Intervertebral disc structure, distinction of the nucleus and the annulus,signal intensity of intervertebral discs, and height of intervertebral discs (26). Due to theheterogeneous distribution in the number of patients in terms of Pfirrmann grade, patientswith grade 4&5 and patients with grade 1&2&3 were pooled to create two groups in theregression model.

2.3.3 Type and location of disc herniation

The type of disc herniation was determined by distinguishing between protrusion,extrusion, and sequestration using T1- and T2-weighted MR images. Protruded typeherniation is defined as disc herniation in which the 'neck' is wider than the herniatedfragment. Extruded type herniation is defined as disc herniation in which the 'neck' isnarrower than the herniated fragment. Sequestered type herniation describes a fragmentthat is no longer contiguous with the disc space [14,28,29].The location of the disc herniation was classified using T1- and T2-weighted MR imagesas central, paracentral, foraminal, and far lateral (30).

2.4. Statistical Analysis

Two-tailed p-values of less than 0.05 were considered statistically significant. Allanalyses were performed on IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp.,Armonk, NY, USA). For the normality check, histograms and Q-Q plots were used. Dataare given as mean ± standard deviation for continuous variables (with respect to normalityof distribution results), and frequency (percentage) are used for categorical variables. Agewas analyzed with the independent samples t test. Categorical variables were analyzedwith chi-square tests (Pearson, Yate's correction) or the Fisher's exact test. Odds ratios(OR) for recurrence were calculated by using univariable logistic regression, and thosewith statistical significance were included in the multivariable logistic regression modelto determine independent risk factors associated with recurrence.

3. Results

The mean age of the recurrent group was 51.48 ± 13.63 years, which was similar to themean age of the non-recurrent group (50.38 ± 14.53) (p = 0.232). 59.6% of recurrentgroup, and 49.8% of non-recurrent group were male, and this difference in sexdistribution was significant (p = 0.002). According to the results of the univariate analysis,the percentage of patients with BMI of >30 (p = 0.004), DM (p = 0.001), LDH on the left(p = 0.049), grade 4 disc degeneration according to PGS (p<0.001), protruded type dischernіation (p<0.001) and who are smokers (p = 0.004) were significantly higher in therecurrent group. The percentage of patients with grade 2 and grade 3 disc degeneration(p<0.001), sequestered type disc herniation (p<0.001), and central and far lateral 140 localization of disc herniation (p = 0.003) were significantly higher in the nonrecurrentgroup **(Table 1)**.

Multivariable logistic regression revealed that sex, DM, smoking, PGS grade, type of dischernіation and location of disc herniation were independent risk factors associated withRLDH. Male patients had 1.474-fold higher risk of RLDH than female patients (OR:1.474, 95% CI: 1.101 - 1.973, p = 0.009). Patients with DM had 1.654-fold higher risk ofRLDH than those without (OR: 1.654, 95% CI: 1.028 - 2.663, p = 0.038). Smokers had 147 2.023-fold higher risk of recurrence than non-smokers (OR: 2.023, 95% CI: 1.455 -2.812,p < 0.001). Patients with grade 4&5 disc degeneration had 4.651-fold higher risk ofRLDH than patients with grade 1&2&3 disc degeneration (OR: 4.651, 95% CI: 3.375 -6.409, p < 0.001). Patients with protruded type LDH had 2.324-fold higher risk ofrecurrence than patients with sequestered type LDH (OR: 2.324, 95% CI: 1.377 - 3.921,p = 0.002) and patients with extruded type LDH had 2.516-fold higher risk of recurrencethan patients with sequestered LDH (OR: 2.516, 95% CI: 1.621 - 3.906, p < 0.001).Patients with paracentral herniation had 5.271-fold higher risk of RLDH than patientswith central LDH (OR: 5.271, 95% CI: 1.550 - 17.926, p = 0.008) and patients withforaminal LDH had 6.460-fold higher risk of RLDH than patients with central LDH (OR:6.460, 95% CI: 1.643 - 25.398, p = 0.008) (Table 2).

4. Discussion

Our study identified several pre-surgical risk factors that are independently associatedwith the development of RLDH, including male sex, diabetes mellitus, smoking,Pfirrmann grade 4&5 disc degeneration, protruded and extruded type LDH, andparacentral and foraminal localization. It is important to avoid surgery beyond the firstdue to elevated risks for surgical complications, and therefore, identifying andrecognizing risk factors associated with recurrence is crucial [7]. In addition, the rate ofRLDH in this study was found to be 26.9%, which is higher than those reported in theliterature [4,6]. Recurrent post-microdiscectomy LDH is a common occurrence, withreported rates ranging from 0.5% to 25% [4,6].

Various pre-operative radiological parameters and classifications have been investigatedfor their role in predicting RLDH [5,18,19,22]. The severity of pre-surgery discdegeneration is among the most frequently investigated factors. Pfirrmann et al. proposeda classification showing the degree of disc degeneration based on the reflection of thestructural changes in disc and loss of disc height on T2-weighted MR imaging as a resultof intervertebral disc degeneration [26]. We found that the risk of RLDH was higher inpatients with Pfirrmann grade 4&5. Similarly, in the univariate analysis of a retrospectivestudy, higher Pfirrmann grade was found to be significantly associated with increased rateof RLDH and revision surgery [19]. Kim et al. showed that the risk of RLDH was greaterin patients with moderate (i.e. grades 3, 4, 5, and 6) disc degeneration compared to othergrades of the Modified PGS [14]. The study of Dora et al. concluded that low-grade discdegeneration (grades 1-3) is an important risk factor for RLDH [31], which is supportedby another recent study [28]. It was stated that the outcomes of these three studies areexplained by the theory put forth by Kirkaldy-Willis and Farfan. This theory suggests thatdisc degeneration progresses at a natural cycle including temporary dysfunction,instability and re-stabilization [14,28,32]. Of note, there are also researchers who arguethat the degree of disc degeneration is not a predictor for RLDH [1,16,33]. Normally, itis considered that disc degeneration impairs the post-discectomy healing process andefficient reconstruction of the external annulus suggesting that the risk of RLDH willincrease as disc degeneration increases [14]. However, these inconsistencies in the results necessitate the existence of more comprehensive studies

Table 1. Summary of patient and herniation characteristics with regard to recurrence

		Recurrence	
	Total (n=1214)	**Absent (n=887)**	**Present (n=327)**
Age	50.68 ± 14.29	50.38 ± 14.53	51.48 ± 13.63
Sex			
Female	577 (47.5%)	445 (50.2%)	132 (40.4%)
Male	637 (52.5%)	442 (49.8%)	195 (59.6%)
Body mass index			
≤30	651 (53.6%)	498 (56.1%)	153 (46.8%)
>30	563 (46.4%)	389 (43.9%)	174(53.2%)
Diabetes mellitus	92 (7.6%)	53 (6.0%)	39 (11.9%)
Hypertension	152 (12.5%)	107 (12.1%)	45 (13.8%)
Coagulopathy	12 (1.0%)	8 (0.9%)	4 (1.2%)
Smoking	373 (30.7%)	252 (28.4%)	121 (37.0%)
Level of disc herniation			
L1-L2	16 (1.3%)	12 (1.4%)	4 (1.2%)
L2-L3	49 (4.0%)	36 (4.1%)	13 (4.0%)
L3-L4	145 (11.9%)	112 (12.6%)	33 (10.1%)
L4-L5	642 (52.9%)	452 (51.0%)	190 (58.1%)
L5-S1	362 (29.8%)	275 (31.0%)	87 (26.6%)
Side of disc herniation			
Right	561 (46.2%)	425 (47.9%)	136 (41.6%)
Left	653 (53.8%)	462 (52.1%)	191 (58.4%)
Pfirrmann grading system			
Grade 1	0 (0.0%)	0 (0.0%)	0 (0.0%)
Grade 2	37 (3.0%)	37 (4.2%)	0 (0.0%)
Grade 3	553 (45.6%)	465 (52.4%)	88 (26.9%)
Grade 4	610 (50.2%)	375 (42.3%)	235 (71.9%)
Grade 5	14 (1.2%)	10 (1.1%)	4 (1.2%)
Type of disc herniation			
Protruded	209 (17.2%)	138 (15.6%)	71 (21.7%)
Extruded	816 (67.2%)	591 (66.6%)	225 (68.8%)
Sequestered	189 (15.6%)	158 (17.8%)	31 (9.5%)
Location of disc herniation			
Central	35 (2.9%)	32 (3.6%)	3 (0.9%)
Paracentral	1081 (89.0%)	782 (88.2%)	299 (91.4%)
Foraminal	55(4.5%)	35(3.9%)	20 (6.1%)
Far lateral	43 (3.5%)	38 (4.3%)	5 (1.5%)

Data are given as mean ± standard deviation for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables

Table 2. Risk Factors of Recurrence, Logistic Regression Analyses

	Univariable		Multivariable
	OR (95% CI)	**p**	**OR (95% CI)**
Age	1.005 (0.997 - 1.014)	0.232	
Sex, Male	1.487 (1.150 - 1.923)	**0.002**	1.474 (1.101 - 1.973)
Body Mass Index, >30	1.456 (1.129 - 1.878)	**0.004**	1.261 (0.955 - 1.664)
Diabetes Mellitus	2.131 (1.380 - 3.291)	**0.001**	1.654 (1.028 - 2.663)
Hypertension	1.163 (0.800 - 1.691)	0.428	
Coagulopathy	1.361 (0.407 - 4.549)	0.617	
Smoking	1.480 (1.132 - 1.935)	**0.004**	2.023 (1.455 - 2.812)
Level of Disc Herniation	0.981 (0.843 - 1.142)	0.808	
Side of Disc Herniation, Left	1.292 (1.000 - 1.669)	0.051	
Pfirrmann Grading System, Grade 4&5	3.541 (2.681 - 4.677)	**<0.001**	4.651 (3.375 - 6.409)
Type of Disc Herniation [(1)]			
Protruded	2.622 (1.623 - 4.237)	**<0.001**	2.324 (1.377 - 3.921)
Extruded	1.940 (1.282 - 2.937)	**0.002**	2.516 (1.621 - 3.906)
Location of Disc Herniation [(2)]			
Paracentral	4.078 (1.240 - 13.418)	**0.021**	5.271 (1.550 - 17.926)
Foraminal	6.095 (1.653 - 22.472)	**0.007**	6.460 (1.643 - 25.398)
Far lateral	1.404 (0.311 - 6.332)	0.659	1.346 (0.286 - 6.329)
Nagelkerke R^2	-		0.187

OR: Odds ratio, CI: Confidence Interval.[(1)] Reference Category: Sequestered.[(2)] Reference Category: Central

to show the definitive effect ofdisc degeneration.Another radiological criterion that has been frequently discussed in studies is LDH type.In the present study, we found that the risk of recurrence was higher in protruded andextruded LDHs compared to sequestered LDH. In one study, it was reported that therecurrence rate after open discectomy was significantly higher in the protruded type thanin the sequestered and extruded type [34].

Another study concluded that a contained discprotrusion is almost three times more likely to require revision surgery than extruded orsequestered discs [35]. Huang et al.'s meta-analysis also obtained consistent results [36].

On the other hand, in a recent study, extruded and sequestered disc herniation wereidentified as risk factors for recurrence [25], which is supported by other studies [15,37].Whereas, many other studies argue that herniation type has no effect on RLDH [1,16,28].

Researchers who found the risk of RLDH to be higher in protruded type hernias claimed that this might be due to the difficulty of complete removal of the herniated disc inprotruded hernia [34]. Some researchers who thought that extruded and sequesteredhernias increase the risk of RLDH attributed this to the avascular structure of theintervertebral disc, the absence of healing of the annulus fibrosis, and development of re-hernia from the defects formed at the site after the initial surgery [15].

According toanother view, extruded and sequestered disc herniation cannot be completely removedand residual nucleus pulposus fragments can lead to postoperative RLDH [25]. As can beseen, the relationship between LDH type and RLDH is still unclear.The last radiological criterion we investigated was hernia localization, and we found thatparacentral and foraminal disc herniation may be a risk factor for RLDH compared tocentral and far lateral localization. Yao et al. argued that the probability of RLDH aftertreatment of central herniation with percutaneous endoscopic lumbar discectomy (PELD)was higher compared to paramedian herniation. However, it was emphasized that thereason for this result was probably the difficulty in removing the central hernia with thesurgical technique applied [22]. Another study of patients with initial PELD showed thatpatients with paracentral disc herniation were more likely to experience early recurrencecompared to patients with central and distant lateral hernias [23]. The authors of this studyalso suggested that when the working channel is placed with a more horizontal trajectoryfor central disc herniation

and with a more vertical trajectory for paracentral and far lateraldisc herniation, the remaining disc material can be minimized, thus reducing thepossibility of recurrence [23]. However, it is notable that the number of studies that didnot find a relationship between hernia localization and hernia recurrence is not low[8,11,20,30].

The most important common feature of these three radiological parameters is that thereare a large number of studies whose results are contradictory. Therefore, in such aheterogeneous pool of results, we think it would be more accurate to investigate why theresults are so different. The effect of these parameters on the risk of RLDH seems to behighly likely to be affected by the type of surgery performed, the individualbiomechanical and anatomical differences of the patients included in the study, and thelimited understanding regarding the pathophysiological mechanism between these factorsand LDH [15, 34, 36]. A more reliable risk classification can be made after these causesof variation can be adjusted for, controlled or stratified.

LDH is a multifactorial disease in which biomechanical, anatomical, hereditary, clinicaland environmental factors play a role [4,16]. Therefore, many other factors other thanradiological parameters are likely to affect the risk of recurrence. In this study, we identified male sex, presence of DM and preoperative smoking as predictors of RLDH inaddition to the radiological parameters discussed above. There are several studies withconflicting results regarding sex distribution. Some report RLDH is higher in men[13,14], some in women [15,33], while various others find similar frequencies [1,2,16].

Higher exposure of men to physical stress factors that can strain the intervertebral disc,such as sports or heavy lifting, may explain why this rate is higher in men in some studies[14]. On the other hand, the opinion that it is seen more in women suggests an associationwith the presence of higher BMI among women [15]. Our multivariable analyses showedthat recurrence was independently associated with being male. With regard to DM, thereare studies showing increased RLDH risk among these patients [5,16], while others havenot found any relationship [1,19]. DM may facilitate the formation of both primary LDHand RLDH with possible mechanisms such as reducing the proteoglycan andglycosaminoglycan density in the disc and/or disrupting nutrition and healing of the disc[20,36]. Similarly, according to some researchers, smoking increases the risk of RLDH[2,5,13,18], while others have not found significant relationships [1,33]. The effects ofsmoking include disruption of the nutrition and oxygenation of the disc, inhibition of cellproliferation, collagen synthesis, extracellular matrix synthesis, and increased intra-discpressure [2,16].

Although this study explored a large set of parameters among a high number of patients,we could not evaluate a few parameters which have been identified as risk factors forRLDH in the literature [22,28]. For example, the diversity of surgeons performing theoperation and surgery type are important factors that may affect the success of theoperation, and therefore, the risk of recurrence [3,5]. Because LDH is a multifactorialdisease, it is an expected result that the results of studies investigating risk factors for recurrence are different. Another important issue is that there is no generally acceptеddefinition of RLDH. We see that many different definitions of RLDH have been made inmany studies [1,3,7,18,33]. This may contribute to the inconsistencies. Conductingcomprehensive prospective studies including all possible and conflicting factors,identifying definitive risk factors for RLDH, and elucidating pathophysiologicalmechanisms with respect to these factors can be useful approached for future studies.

5. Study limitations

While evaluating the results of this study, it is necessary to consider potential pitfalls.Although this is a two-center study with a large number of participants, thereby enablingreliable generalizability, it should be noted that data were recorded retrospectively. Otherrisk factors such as occupation [18], high-intensity postoperative activity [23,25] andother radiological parameters [28] could not be investigated. As the follow-up period ofeach patient was not the same and only symptomatic patients who applied to the healthinstitution for possible recurrence were included in the RLDH group, the actual incidenceof RLDH may not have been obtained. In addition, revision surgery-related data and the exact time interval between recurrence and initial surgery were not available for allpatients in the recurrent group; thus, analyses concerning these parameters were notincluded in the study. The impact of patients' lifestyle differences and occupationalintensity on recurrence was not investigated. Also, The difference in complication ratesbetween the surgeons could not be evaluated since some of the patients included in thestudy had their first operation performed at a different center.

6. Conclusion

In conclusion, male sex, DM, smoking, Pfirrmann grade 4&5 disc degeneration,protruded and extruded type LDH, and paracentral and foraminal localization were foundto be independent pre-surgical risk factors associated with RLDH development. In orderto reduce the rate of RLDH and revision surgery, it is critical to minimize the effects ofmodifiable risk factors (both before and after the initial surgery). Also, patients withunmodifiable risk factors must be made aware of the high likelihood of recurrence

aftersurgery, and alternative treatment methods should be offered when possible. However,first of all, a common definition of RLDH should be made and more comprehensive,multicenter studies should be conducted to clarify the conflicting results regardingrecurrence-related risk factors.

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