Retrospective Study

Clinical and Radiological Risk Factors of Early Recurrent Lumbar Disc Herniation at Six Months or Less: A Clinical Retrospective Analysis in One Medical Center

Jianwei Guo, MD[1], Guanghui Li, MD[1], Xiangli Ji, MD[2], Xiaoqi Wu, MD[1], Guoqing Zhang, MD[1], Chuanli Zhou, MD[1], Xuexiao Ma, MD[1]

From: [1]Department of Orthopedics, The Affiliated Hospital of Qingdao University, Qingdao, Shandong Province, People's Republic of China;[2]Department of Intensive Care Unit, Qilu Hospital of Shandong University (Qingdao), Qingdao, Shandong Province, People's Republic of China

Address Correspondence:
Xuexiao Ma, MD
Department of Orthopedics, The Affiliated Hospital of Qingdao University
16 Jiangsu Road
Qingdao 266003, Shandong Province, P.R. China
E-mail:
maxuexiaospinal@163.com

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Background: Recurrent LDH (rLDH) is one of the most common causes of unsatisfactory outcomes after discectomy, which usually needs secondary surgery and leads to physical and psychological suffering for patients and substantial costs for society.

Objectives: This study was conducted to analyze the risk factors of early rLDH (≤ 6 months) and to reduce the incidence of early rLDH.

Study Design: A clinical retrospective study.

Methods: A total of 1,228 patients received percutaneous endoscopic lumbar discectomy surgery from January 2013 through December 2016; there was a minimum 5-year follow-up. Seventy-seven of them (6.27%) developed recurrences and were included in this study. According to the differences in recurrent time, patients were divided into 2 groups (≤ 6 months and > 6 months). Clinical and radiological parameters were retrospectively collected through chart review and preoperative imaging. All related risk factors were collected and analyzed relative to the time of recurrent herniation.

Results: Patients with rLDH at ≤ 6 months and > 6 months were 49 and 28, respectively. Recurrence most often occurred within 6 months postoperatively, which was 63.6% of the total patients with rLDH. Of those risk factors, Modic changes, disc height index (DHI), and facet orientation (FO) showed significant statistical differences $P = 0.003$, $P = 0.036$, and $P = 0.007$, respectively). A logistic regression analysis was performed and showed there was an independent significant relationship between Modic changes ($P = 0.042$) and FO ($P = 0.005$) and early rLDH.

Limitations: First, this was a retrospective nonrandomized study, and the number of patients with rLDH included in this study was relatively small. Second, limited risk factors were assessed in this study, and some relevant risk factors that were identified as significant independent predictors in other studies were not included in this study, such as canal diameter, annular defect size, migrated disc, and foraminoplasty. Third, this study compared the clinical and radiological parameters of patients with rLDH at different times, and one case-control study is needed for further study, especially in terms of standardized sampling and data classification.

Conclusion: This study demonstrated that the recurrence rate of LDH at 5-year follow-up was 6.27% and there was a significant statistical relationship between FO, DHI, and Modic changes and early rLDH. Surgeons should take FO angles, DHI, and Modic change into consideration before surgery to achieve a satisfactory postoperative outcome and a relatively lower early recurrence rate. More patients and further investigation should be taken to assess the risk factors for early rLDH.

Key words: Lumbar disc herniation, percutaneous endoscopic lumbar discectomy, recurrence, risk factor

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Lumbar disc herniation (LDH) is one of the most frequent disorders of the lumbar spine, causing back and leg pain. Surgical treatment of LDH is believed to be a useful and effective procedure. Percutaneous endoscopic lumbar discectomy (PELD), a minimally invasive surgery for the treatment of LDH, has been increasingly used and has achieved successful outcomes. PELD has obvious advantages such as smaller incisions, less damage to soft tissues, a clear surgical field, shorter operation time and hospital stays, reduced blood loss, and faster recovery (1-3). However, there are still unsatisfactory outcomes in 5%-20% of LDH cases (2,4,5). The most common cause of unsatisfactory outcomes after discectomy is recurrent LDH (rLDH), which has been reported to occur in 5%-15% of cases (2,4,6).

rLDH is defined as a disc herniation at the same level as a prior surgery, regardless of ipsilateral or contralateral herniation (7). It may be caused by the disc being retained or further disc material extruding from the disc space, scar tissue associated with the first discectomy, or inadequate decompression of the neural elements caused by bone, the annulus, or the ligamentum flavum (7,8). Secondary surgery is usually needed, which leads to physical and psychological suffering for patients and substantial costs for society. Therefore, it is very important to analyze the risk factors for rLDH and reduce its incidence.

Today there are still debates about risk factors associated with rLDH. Various risk factors have been reported in early studies, such as age, gender, body mass index (BMI), smoking, herniation type, diabetes mellitus (DM), hypertension (HTN), degree of herniation, and herniation level (6,7,9,10). However, risk factors in those studies were not always consistent. Besides, radiological parameters associated with rLDH have seldom been discussed in those studies. What's more, those studies did not report the risk factors associated with early rLDH (≤ 6 months). Therefore, we conducted this study to analyze the clinical characteristics of rLDH and to identify clinical and radiological risk factors associated with early rLDH.

Methods

This study is a clinical retrospective study. It was approved by the institutional ethics committee of Affiliated Hospital of Qingdao University. A total of 1,228 patients received PELD surgery from January 2013 through December 2016 with a minimum of 5 years of follow-up. Seventy-seven of them developed recurrences, with a recurrence rate of 6.27%. These patients were included in this study.

All patients with rLDH had suspected signs and symptoms postoperatively. A postoperative magnetic resonance imaging scan was performed to identify any pathological lesions. In this study, rLDH was defined as symptom relapse associated with disc herniation at the same level as a prior surgery after a pain-free period of at least 2 weeks, regardless of ipsilateral or contralateral herniation. Exclusion criteria were patients who were lost to follow-up or whose follow-up time was less than 5 years, before lumbar surgery at another institution, segmental instability, vertebral fractures, spinal infections, or those with obvious degenerative spinal diseases such as lumbar scoliosis, stenosis, or spondylolisthesis, or a symptomatic disc at another level.

Clinical and radiological parameters were retrospectively collected through chart review and preoperative imaging, including age, gender, BMI, smoking status, alcohol use, DM, hypertension, marital status, surgical procedure, recurrent time, level of LDH, Modic type, herniation type, grade of disc degeneration, anterior longitudinal ligament, and herniation calcification of the surgical level, facet orientation (FO), facet tropism (FT), lumbar lordosis angle (LLA), sacral slope, disc height index (DHI), and sagittal range of motion.

The grade of disc degeneration was assessed on T2-weighted sagittal sequences according to Modic changes, herniation type, and modified Pfirrmann criteria (11-13). FO is defined as the average angle of the facet joints in the transverse plane relative to the sagittal plane, which is calculated as the average angles between the line of the midsagittal plane of the vertebra and the lines through each facet joint tangential to the superior articular process (14).

FT is defined as asymmetry of the left and right vertebral (zygapophysial) facet-joint angles, which is calculated through the differences between the left and right vertebral (zygapophysial) facet-joint angles and showing the sagittal orientation of the surgical level (15) (Fig. 1). LLA is the angle between the superior endplate of the L1 vertebra and the S1 vertebra. The sacral slope is defined as the angle between the superior endplate of the S1 vertebra and the horizontal line. DHI is the ratio between the height of the disc and the average height of the upper and lower vertebra (16) (Fig. 2). The sagittal range of motion is the differences in angulation between extension and flexion at the surgical level. In order to prevent interobserver variability, measurements were performed by 2 surgeons who were blinded to the operative details to get the average.

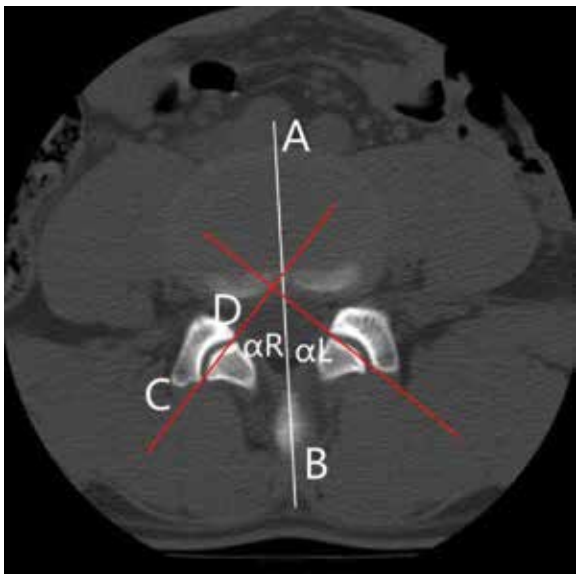

Fig. 1. *Calculation of facet joint angle. AB is the midline which crosses the center of the lumbar vertebral body and the middle point of the spinous process and divides the vertebra and the spinous process into 2 symmetrical parts. CD is the facet line which is drawn between 2 peaks of the superior articular facets (C and D). The facet angle is the angle between the midline and the facet line (αR = right facet angle, c = left facet angle). FO =(αR+αL)/2, FT = |αR-αL|*

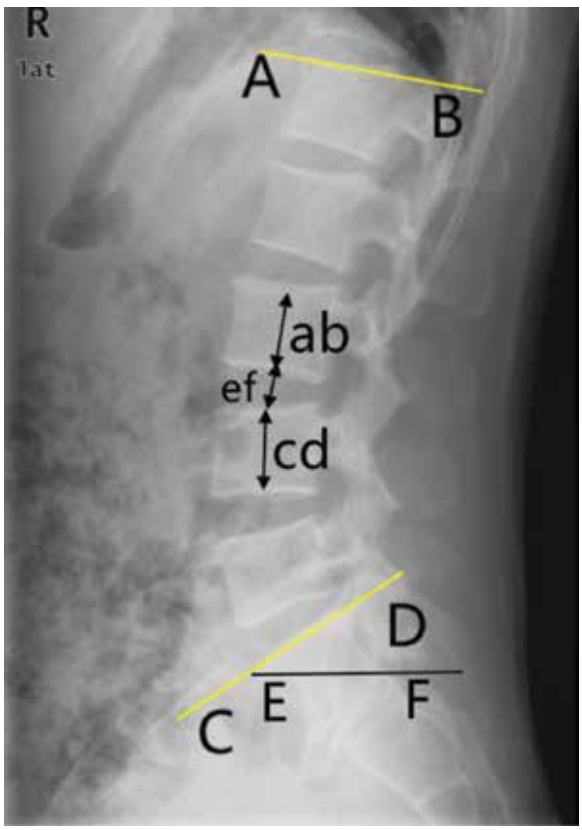

Fig. 2. *LLA is the angle between the superior endplate of the L1 vertebra (AB) and S1 vertebra (CD). SS is defined as the angle between the superior endplate of the S1 vertebra (CD) and the horizontal line (EF). DHI is the ratio between the disc height and the average height of the upper and lower vertebrae. DHI = 2ef/(ab+cd)*

Surgical Procedure and Postoperative Management

Different surgical procedures, including percutaneous endoscopic transforaminal discectomy and percutaneous endoscopic interlaminar discectomy, were selected based on the locations and types of lumbar disc herniation and the surgeons' specialty.

All patients were able to walk one day postoperation with the protection of a lumbar brace. Patients were suggested to stay in bed except for eating and going to the toilet for 2 weeks postoperatively. Full activities were allowed at one month postoperatively until the fibrous scar tissue at the disc gap was considered strong. Lumbar computed tomography was routinely performed at 3 months, 6 months, one year, and at yearly intervals. Postoperative magnetic resonance imaging is not routinely performed due to higher costs and a longer appointment time, except for those with suspected signs and symptoms of leg pain.

Statistical Analysis

All related risk factors were collected and analyzed relative to the time of recurrent herniation. Clinical and radiological parameters during the hospitalization and follow-up periods were expressed as the mean ± SD. Univariate analysis was performed using the independent t test, χ^2 test, Fisher's exact test, and the univariate logistic regression for clinical and radiologic parameters. All statistical analyses were performed using The Statistical Package for Social Sciences software for Windows Ver. 17.0 (SPSS Inc.); $P < 0.05$ was considered statistically significant.

Results

A total of 1,228 patients underwent PELD surgery from January 2013 through December 2016 with a minimum of 5-year follow-up. Seventy-seven of them developed recurrences with a recurrence rate of 6.27%. The demographic and clinical characteristics of patients are collected in Table 1. According to the differences in recurrence time, patients were divided into 2 groups

Table 1. *Patient characteristics*.

Patient Characteristics	
No. of patients	77
Age (years)	56.8 ± 14.6
< 30 years	4
30–60 years	38
>60 years	35
Gender	
Men	46
Women	31
BMI (kg/m^2)	25.99 ± 3.89
< 25	35
≥ 25	42
Duration of pain before surgery (months)	
Smoking (%)	
Yes	60
No	17
Alcohol use history (%)	
Yes	64
No	13
Diabetes/DM (%)	
Yes	75
No	2
Hypertension (%)	
Yes	67
No	10
Marital Status (%)	
Married	43
Unmarried	34
Surgical procedure	
PETD	35
PEID	42
Recurrence time	
≤ 6 months	49
> 6 months	28
Level of rLDH	
L1-2	7
L2-3	8
L3-4	1
L4–L5	43
L5–S1	18

Abbreviations: BMI, body mass index; PETD, percutaneous endoscopic transforaminal discectomy; PEID, percutaneous endoscopic interlaminar discectomy; rLDH, recurrent lumbar disk herniation

(≤ 6 months and > 6 months). Patients with rLDH at ≤ 6 months and > 6 months were 49 and 28, respectively. Recurrence most often occurred within 6 months postoperatively, occupying 63.6% of the total patients with rLDH.

Clinical parameters (age, gender, BMI, smoking status, alcohol use, DM, hypertension, marital status, surgical procedure, recurrence time) and radiological parameters (level of LDH, Modic type, herniation type, grade of disc degeneration, anter-ossification and herniation calcification of surgical level, FO, FT, LLA, SS, DHI, and sagittal range of motion) are collected and analyzed in Table 2. Of those risk factors, Modic changes, DHI and FO showed significant statistical differences with $P = 0.002$, $P = 0.036$, and $P = 0.007$, respectively. A logistic regression analysis was performed and revealed there were significant relationships between Modic changes ($P = 0.042$) and FO ($P = 0.005$) and rLDH.

Discussion

rLDH is the most common cause of reoperation, leading to an unsatisfactory outcome following primary discectomy for lumbar disc herniation. It has been reported to occur in 5%-15% of patients treated surgically for primary lumbar discectomy (2,4,6). It is commonly caused by remnants of surgical disc fragments and incomplete decompression, especially in early recurrences (7,8). Robert et al, (17) reported that 9.1% of patients underwent revision surgery secondary to reherniation within an 8-year follow-up period, with 37.8% of all revision surgeries occurring in the first postoperative year. Davis et al, (18) reported a reherniation rate of 6% at 10-year follow-up, with one-third of all revision surgeries occurring in the first postoperative year. Vik et al (19) reported a reherniation rate of 8.6% within an 8-year follow-up, with nearly 50% of reoperations occurring in the first postoperative year (19). In our study, 6.27% of patients had revision surgeries following primary PELD discectomy within at least a 5-year follow-up, and 63.6% of the total patients had their rLDH occur within the first postoperative 6 months, which is consistent with earlier reports just cited (17-19). Due to the high occurrence rate and unsatisfactory outcome of rLDH, it is essential to identify the risk factors associated with early rLDH and reduce its occurrence rate.

Several clinical risk factors have been reported to be associated with the occurrence of rLDH in earlier literature, such as age, gender, obesity, smoking, alcohol use, diabetes, and undergoing a traumatic event

(6,7,9,10). Kim et al, (20) reported that there were associations between old age, high BMI, protrusion type of disc herniation, and positive Modic changes and rLDH, while Suk et al, (21) reported young age, men, smoking, and traumatic events as risk factors. Wilke et al, (22) believed that discs of younger patients were more likely to reherniate under mechanical stress, while discs of patients older than 55 were unlikely to reherniate due to fibrosis of the nucleus. They believed that old age likely protected against reherniation. On the other hand, Swartz et al, (23) found that there was no association between age, gender, smoking status, level of herniation, duration of symptoms, and rLDH. In our study, we found no statistically significant relationship between age, gender, smoking, alcohol use, diabetes, hypertension, and early rLDH, which is consistent with earlier reports (6,7,9,10). Due to the complicated causes of rLDH, even now there is still no consensus or reliable conclusions regarding risk factors for rLDH.

Except for clinical parameters, radiological and biomechanical parameters have been reported to be associated with rLDH (6,7,10,14,24). In our study, we found Modic changes, DHI, and FO showed significant statistical differences with $P = 0.002$, $P = 0.036$, and $P = 0.007$, respectively. Modic changes, indicating the degeneration and inflammation degree of the corresponding area, have been identified as a risk factor for rLDH (6,10). Increases in disc degeneration may cause larger volumes of herniation type and instability (7,25). Therefore, some studies have suggested treating Modic type 1 and 2 lesions that lead to degenerative disc disease with posterior dynamic stabilization (26). Another suggested treatment is posterior lumbar interbody fusion combined with pedicle screw fixation (27).

Because a preoperatively large disc height could lead to a larger disc height decrease after nucleus removal and increased segmental mobility, DHI has been suggested to have a significant correlation with the occurrence of rLDH (22,28,29). FO, a biomechanical parameter of facet joints, reflects alterations in the mechanical properties of the facet joints with

Table 2. *Analysis of clinical and radiological parameters according to recurrence time for the recurrence group using univariate and logistic regression analysis.*

n = 77	Recurrence Time Course		Univariate Analysis	Logistic Regression Analysis
	≤ 6 months	6 months	*P* value	*P* value
Age (years)	52.9 ± 15.6	51.8 ± 13.5	0.753	
Gender ratio				
Men	28	18	0.539	
Women	21	10		
BMI (kg/m^2)	26.31 ± 4.24	25.13 ± 3.12	0.202	
< 25	21	14	0.636	
≥ 25	28	14		
Smoking (%)				
Yes	38	22	1	
No	11	6		
Alcohol use history (%)				
Yes	42	22	0.53	
No	7	6		
Diabetes/DM (%)				
Yes	48	27	1	
No	1	1		
Hypertension (%)				
Yes	44	23	0.337	
No	5	5		
Marital Status (%)				
Married	26	17	0.653	
Unmarried	23	11		
Surgical procedure				
PETD	23	12	0.814	
PEID	26	16		
Location of rLDH				
L1-2	4	3	0.574	
L2-3	7	1		
L3-4	1	0		
L4–L5	26	17		
L5–S1	11	7		
Modic changes				
0	1	7	0.002	0.042
1	10	2		
2	38	19		
Herniation Type				
Central	40	27	0.083	
Paramedian	9	1		

Table 2 (cont.). *Analysis of clinical and radiological parameters according to recurrence time for the recurrence group using univariate and logistic regression analysis.*

n = 77	Recurrence Time Course		Univariate Analysis	Logistic Regression Analysis
	≤ 6 months	6 months	*P* value	*P* value
Pfirrmann				
3	13	4	0.263	
4	36	24		
Ossification of the anterior longitudinal ligament				
0	30	21	0.468	
1	16	6		
2	3	1		
Calcified Herniation				
0	33	22	0.432	
1	16	6		
Facet Orientation	3.73 ± 2.06	5.27±2.74	0.007	0.005
Facet Tropism	5.11 ± 3.86	4.04±4.58	0.276	
LLA	40.32 ± 11.24	36.09±11.63	0.121	
SS	29.50 ± 8.27	30.33±8.17	0.672	
DHI	0.35 ± 0.10	0.31±0.07	0.036	0.068
sROM	6.82 ± 4.18	6.68±5.26	0.900	

Abbreviations: BMI, body mass index; PETD, percutaneous endoscopic transforaminal discectomy; PEID, percutaneous endoscopic interlaminar discectomy; rLDH, recurrent lumbar disk herniation; LLA, lumbar lordosis angle; SS, sacral slope; DHI, disc height index; sROM, sagittal range of motion

stress and aging (14). The role of FO in the development of LDH is controversial. Some studies reported that FO is significantly related to lumbar facet joint asymmetry, which is more likely to cause instability and LDH (30-33). In contrast, other scholars believe that lumbar facet joint asymmetry is a congenital structural manifestation, which is not due to age or degeneration (34,35).

This study has several limitations. First, this was a retrospective nonrandomized study and the number of patients with rLDH included in this study was relatively small. Second, limited risk factors were assessed in this study. Some relevant risk factors that were identified as significant independent predictors in other studies were not included in this study, such as canal diameter, annular defect size, migrated disc, and foraminoplasty. Third, this study compared the clinical and radiological parameters of patients with rLDH or without rLDH at different times, and for the future, case-control studies will be needed, especially in terms of standardized sampling and data classification.

Conclusion

This study demonstrates that the recurrence rate of LDH at 5-year follow-up was 6.27%. Patients with smaller FO angles, higher DHI, and Modic changes had a higher tendency for early rLDH. Surgeons should take FO angles, DHI and Modic change into consideration before surgery to achieve a satisfactory postoperative outcome and a relatively lower early recurrence rate. More patients and multicenter studies will be needed in the future to evaluate the risk factors for early rLDH.

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