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Research Article

Effects of Enhanced Recovery Rehabilitation Surgery Concepts on the Surgical Process, Postoperative Pain, Complications, and Prognosis of Discectomy in Patients with Lumbar Disc Herniation: A Systematic Review and Meta-Analysis

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Objective. The purpose of this study was to investigate the effect of lumbar disc herniation (LDH) disease degree on lumbar discectomy and to explore the relationship between the degree of intervertebral disc disease and postoperative pain score changes. *Methods*. We conducted a comprehensive search in China National Knowledge Infrastructure (CNKI), Wanfang Data, PubMed, MEDLINE, Embase, Cochrane database, and other databases, obtained all relevant studies as of April 2017, and then followed strict inclusion and exclusion criteria. Standard screening was performed on the retrieved literature. We extract and analyze key data using Review Manager 5.3 software. Pooled effects were calculated by mean difference or odds ratio and 95% confidence interval analysis, depending on data attributes. *Results*. Various databases were searched for the results of papers from lumbar discectomy since April 2017 to April 2022. Nine papers from 2502 patients were selected. The average overall follow-up was 52 weeks. There were statistically significant reductions in postoperative pain scores and degree of disc disease. There was a significant correlation between the reduction in pain score after discectomy and the degree of disc disease ($r = 0.73$, 95%CI = 0.01-1.20, $p = 0.005$). *Conclusions*. Decreased disc disease grade is one of the reasons for the lower back pain score after discectomy. Furthermore, region-dependent economic factors must be considered before developing a treatment strategy. Larger, well-defined randomized controlled trials are needed to further confirm these results.

1. Introduction

Low back pain (LBP) is one of the most common causes of disability (temporary or permanent) among workers and is associated with significant socioeconomic and healthcare burdens [1–3]. The prevalence of lumbar disc is about $11.9 \pm 2.0\%$, and 50-70% of the general population will suffer from low back pain at least once in their lifetimes [4, 5]. LBP is a series of symptoms caused by intervertebral disc degeneration (IDD) [6–8] (lumbar disc herniation (LDH)). Despite advances in clinical and basic research on lumbar disc herniation, there is currently no consensus on research on its risk factors and pathophysiology [9, 10]. Magnetic resonance imaging (MRI) is an important tool for quantifying disc degeneration and can be used for noninvasive clinical assessment of intervertebral disc pathology, reflecting disc changes caused by aging or degeneration, and identifying disc degeneration T2 (T2W) on weighted images [11–12]. Normal disks have higher signal strength in the middle and lower signal strength at the periphery [13, 14]. Pfirrmann et al. developed a classification system for the degree of intervertebral disc degeneration based on T2WI results [15, 16].

When degenerative changes occur in patients with lumbar disc herniation, biochemical changes often follow. During this process, the intervertebral disc tissue often has a series of pathological changes such as water loss and annulus fibrosus rupture, and the nucleus pulposus often occurs at the ruptured annulus fibrosus, which causes mechanical damage and compression to the cauda equina and nerve roots. Some specific typical clinical symptoms such as lower extremity radiating pain and low back pain [17]. If the condition of patients with lumbar disc herniation is more serious, it can lead to symptoms such as lower limb muscle strength, bowel and bladder dysfunction, foot drop, and other symptoms. With the further development of the disease, some patients may even lead to paralysis. With the gradual improvement of living standards and the continuous increase of social pressure, more and more patients with lumbar disc herniation have become a serious medical problem with significant clinical significance that is recognized worldwide and affects health and quality of life. Prevention and treatment have always been the focus and research focus of clinical orthopedic surgeons. Under the current medical level, the treatment methods for patients with lumbar disc herniation can be summarized into three categories: interventional treatment, conservative treatment, and surgical treatment, each of which has certain application value. Although conservative treatment and intervention can relieve pain symptoms, the effect is not significant in improving activity function and quality of life, and the time of therapy is long. Surgical treatment often has good curative effect for patients with more severe disease, but this kind of program is more traumatic and affects the process of postoperative recovery [18]. It can be seen that it is of great clinical significance to actively explore efficient, safe, and minimally invasive treatment methods for patients with lumbar disc herniation.

The present study further analyzed the correlation between lumbar disc degeneration grade and pain scores, including visual analogue scale (VAS), Oswestry Disability Index (ODI), and Japanese Orthopaedic Society Score (JOA), thus providing a new candidate method for diagnosis of patients' disease severity.

2. Methods

2.1. Literature Retrieval. On April 10, 2022, a systematic review was conducted by searching China National Knowledge Infrastructure (CNKI), Wanfang Data, PubMed, MEDLINE, Embase, Cochrane database, and other databases. Related studies on the degree of lesions and pain index after lumbar disc surgery were searched from April 2017 to April 2022. The search keywords were as follows: "Lumbar disc herniation", "microdiscectomy", " endoscopic lumbar discectomy", "degree of disc lesion", "grading of disc lesion", "pain after discectomy", with appropriate combination of operators "AND", "OR" AND "NOT", the language included in the study was limited to English. Relevant references are reviewed for further research.

2.2. Inclusion Criteria. Inclusion criteria are as follows:

(1) Randomized controlled trials (RCTS) and nonrandomized controlled trials of any discectomy (microscopic endoscopic discectomy (MED), percutaneous endoscopic lumbar discectomy (PELD), and microscopic discectomy (MD)) for symptomatic LDH patients)

(2) The subjects were patients with lumbar disc herniation

(3) LDH patients have pain symptoms, including at least one of low back pain, back pain, or leg pain

(4) Diagnosis of lumbar disc herniation according to Pfirrmann grading standard

(5) The literature language is only English

(6) Pain score indicators include visual analog scale (VAS), Oswestry Disability Index (ODI), and Japanese Orthopaedic Society Score (JOA)

2.3. Exclusion Criteria. Exclusion criteria are as follows:

(1) Meta-analysis, review articles, case reports, conference papers, and dissertations

(2) The patient did not undergo lumbar discectomy

(3) The follow-up time was too short, at least three months

(4) In vitro biomechanical study and computational model study

(5) If two or more studies submitted to the same authority overlap, the latter is used and the other studies are removed

(6) Two investigators independently searched the database and independently selected studies for inclusion. Resolve any differences by discussing them with other authors in nonlow back pain patients

(7) The test results are not clear indicators

(8) Unable to obtain full text, incomplete data, low quality, duplicate literature

(9) Studies on the literature reported as individual cases

2.4. Literature Screening. The study was independently reviewed and selected by two reviewers based on the title and abstract of the first stage paper and the full text of the second-stage paper. Cases of disagreement are settled by consensus. References to included articles and previous systematic reviews were reviewed to identify other relevant articles. We collect the required parameters using a standardized form, as follows:

(1) Basic characteristics of the study and population, including author information, publication year, study design, number of patients, age, sex, type of surgery, and duration of follow-up

(2) Preoperative and final follow-up functional outcomes, including the Oswestry Disability Index (ODI), visual analog scale vas-back pain, and VAS-leg pain

2.5. Quality Evaluation. Items in each study were assessed for risk of bias according to the Cochrane Handbook for

Systematic Reviews of interventions [19]. All studies were evaluated from six dimensions of randomization, allocation concealment, double-blindness, outcome assessment, data integrity, and reporting selection. The statistical software RevMan5.3 summarizes the results of the risk of bias assessment and generates a summary graph of bias risk.

In addition, data quality was judged as high, moderate, low, or very low based on risk of bias, indirect risk, inconsistency, imprecision, and publication bias according to the Grading, Evaluation, Development, and Evaluation (GRADE) system [20]. The Newcastle-Ottawa Scale (NOS) was used to assess the methodological quality of the included observational studies. NOS "star systems" range from 0 to 9, and studies that earn 7 stars or more are considered high quality [21]. Sensitivity analyses were performed in included studies with a higher overall risk of bias. This assessment was conducted independently by two authors, and their respective differences of opinion were resolved in a discussion among the three authors.

2.6. Statistical Methods. Data were extracted from each included study for summarization, and the table contained the following information: article identification, methods, efficacy measures, and results. $P < 0.05$ and/or 95% confidence interval (CI) of ratio effect measurement (relative risk (RR), odds ratio (OR), or hazard ratio (HR)), excluding 1 was considered statistically significant. Effect sizes were calculated where ratios or ratio effect sizes were not reported and raw data were available. Meta-analysis was conducted on the original data of at least three studies on lumbar disc degeneration, and the contents of these studies were determined to be similar to those of this paper.

Review Manager software (RevMan5.3) was used for statistical analysis of the data. Results are expressed as mean difference IV (MD) or odds ratio (ORs) with 95% confidence intervals (CI). $P < 0.05$ is statistically significant unless otherwise noted. In addition, Q test and I^2 statistical method were used to quantify heterogeneity. When heterogeneity test showed no significant difference ($P > 0.05$ and $I^2 < 50\%$), the fixed-effect model was adopted. Otherwise, the data are considered heterogeneous and random effects models are used. Begg's funnel plot tests were used to assess possible publication bias. Sequential trial analysis (TSA) was used to determine whether the sample size was large enough to produce significant results.

3. Results

3.1. Literature Retrieval Results. After a systematic database search, an initial search of 733 studies was conducted, titles and abstracts were carefully scanned, and 346 duplicate articles were removed. After careful screening, 324 unrelated topics, reviews, case reports, and meta-analysis studies were removed. Full text of the remaining 52 articles was carefully evaluated. 9 studies that met the inclusion and exclusion criteria were eventually included in this meta-analysis [22–30]. A total of 2505 patients were included in this analysis, and the basic characteristics of the included study are shown in Table 1. The flow chart of literature selection process is shown in Figure 1.

3.2. Basic Features. All English literature published between 2017 and 2022 were used. There were 2505 patients in the nine studies, all of whom received different types of lumbar disc surgery. All but one of the studies recruited a slightly higher proportion of women than men. The range of lumbar intervertebral disc was L2/3, L3/4, L4/5, L5/S, and the severity of lumbar intervertebral disc degeneration was Pfirrmann I ~ PfirrmannV. Follow-up was 52 days to 100 weeks.

3.3. Methodological Evaluation and Bias Assessment of Risk Results. The characteristics of the nine included studies are shown in Tables 1 and 2. Of the 9 included studies, 2 did not report randomization, 4 did not provide information on allocation concealment, 7 were double-blind, 2 studies were documented with ambiguous bias, one could not determine whether patients were lost to follow-up due to incomplete data, and the data from the other were not reported in detail. The results of methodological evaluation are shown in Table 2, and the results of bias risk assessment are shown in Table 3.

3.4. Meta-Analysis Results

3.4.1. Results of Changes in Preoperative and Postoperative Pain Levels. A total of 2185 subjects were included in 8 literatures, and preoperative and postoperative changes in pain scores were compared, including VAS score, ODI score, and JOA score. The results showed that VAS score was heterogeneous ($P < 0.00001$, $I^2 = 99\%$), and VAS score was lower after surgery than before surgery (SMD = 3.0, 95% CI (0.92, 5.08), $P < 0.05$) by random effect model analysis. The forest map results are shown in Figure 2. The heterogeneity of the ODI score was large ($P < 0.00001$, $I^2 = 99\%$), and the ODI score after surgery was lower than that before surgery (SMD = 3.38, 95% CI (1.48, 5.28), $P < 0.05$) by random effect model analysis. The forest map results are shown in Figure 3. The heterogeneity of JOA score was large ($P < 0.00001$, $I^2 = 61\%$), and the JOA score after surgery was lower than that before surgery (SMD = −3.37, 95% CI (-4.37, -2.37), $P < 0.05$). The forest map results are shown in Figure 4.

3.4.2. Meta-Analysis of Postoperative Pain and the Degree of Lumbar Disc Degeneration by Pfirrmann Classification. A total of 7 literatures were included in this study, including 2409 subjects, to meta-analyze the influence of Pfirrmann grading factors on postoperative pain, with heterogeneity ($P < 0.05$). A random effect model was used for analysis, and the difference was statistically significant ($RD = -0.03$, 95% CI (-0.05, 0.00), $P < 0.05$).

In this paper, they were divided into two groups, grade i-ii and iii-v. Heterogeneity test analysis showed that $I^2 = 0\%$, there was no significant heterogeneity, which could be analyzed by fixed-effect model. The results of meta-analysis showed that there was significant difference between the grade of lumbar disc degeneration and postoperative pain. Pfirrmann grade of lumbar disc degeneration is an

Table 1: Baseline characteristics of included studies.

Author	Year	Number	Surgery	Age	M/F	Disc extent	Disc number	Outcome	Characteristics	Follow-up (mouth)
Hiroshi Takahashi	2021	65	Hemilaminectomy	43.6	34/31	L3/4	6	VAS	Backache, leg ache, lower back ache	12
			Tubular retract discectomy			L4/5	28			
			Bilateral lamina discectomy			L5/S	31			
Xijia Jiang	2018	120	Transforaminal endoscopic discectomy	45.2 ± 12.1	45/75	L2/3	11	VAS	Backache, leg ache	12
			Interlaminar endoscopic discectomy			L3/4	14			
						L4/5	60			
						L5/S	35			
Yang Qu	2017	16	Discectomy under microendoscope	40.4 ± 5.9	10/6	L4/5	16	VAS	Backache, leg ache	31
Jenny C. Kienzler	2020	267	Lumbar discectomy	42.9	155/112	L2/3	2	VAS	Backache, leg ache	6
						L3/4	8			
						L4/5	121			
						L5/S	136			
Xiang Gao	2020	123	Percutaneous endoscopic lumbar discectomy	45.6 ± 11.6	63/60	L2/3	2	VAS	Backache, leg ache	6
						L3/4	3			
						L4/5	57			
						L5/S	61			
Yueyang Li, MS	2021	1529	Percutaneous endoscopic lumbar discectomy	46.73 ± 15.41	913/616			VAS	Backache, leg ache	6
Kang Li	2019	35	Percutaneous interforaminal endoscopic lumbar discectomy	47.1 ± 8.6	19/16	L3/4	11	VAS	Backache, leg ache	6
						L4/5	24			
Sherwan A.	2020	30	Fenestration discectomy	40		L4-L5		VAS	Backache, leg ache	6
Mengxian Jia	2021	320			212/108	L3/4	12	VAS	Backache, leg ache	6
						L4/5	165			
						L5/S	143			

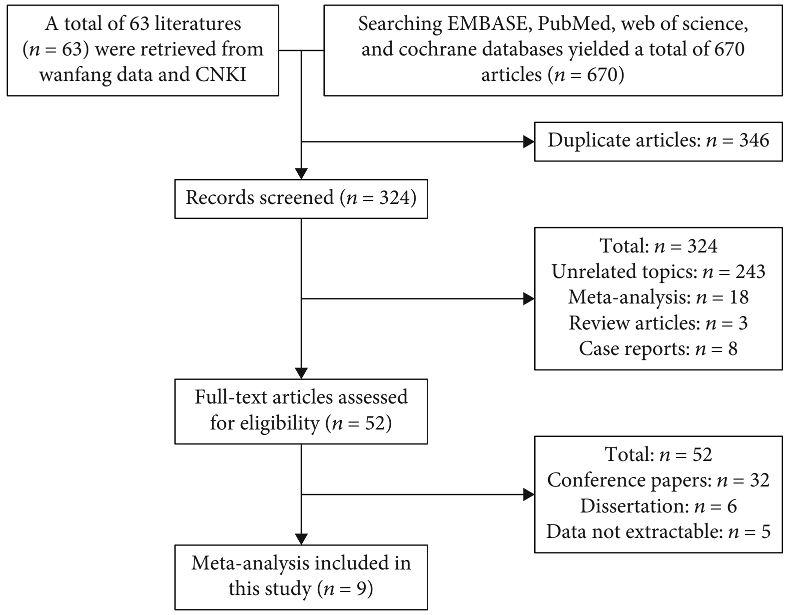

Figure 1: Flow chart of the literature search strategy.

Table 2: Assessment of the methodological quality of included studies.

First author	Published year	Evaluation project				
		Randomly generated	Distribution of hidden	Double-blind	Outcome integrity	Other bias
Hiroshi Takahashi	2021	1	1	3	2	1
Xijia Jiang	2018	1	2	1	3	2
Yang Qu	2017	2	1	2	1	2
JennyC. Kienzler	2020	1	1	1	2	1
Xiang Gao	2020	1	2	1	1	1
Yueyang Li, MS	2021	1	2	1	1	2
Kang Li	2019	2	2	1	2	1
Sherwan A.	2020	1	1	1	1	2
Mengxian Jia	2021	1	2	1	2	3

Note: 1 stands for low risk, 2 represents unknown risk, and 3 is high risk.

Table 3: Egger method to detect publication bias results.

Category	Literature number	T value	P values
I, II	2	-0.12	0.84
II, III	4	1.11	0.12
III, IV	6	1.32	0.27
IV, V	6	0.78	0.22

important factor affecting surgery, and the higher the grade of degeneration, the higher the pain index (OR = 0.40, 95% CI: 0.19-1.87, $P = 0.02$), as shown in Figure 5.

4. Discussion

The pathogenesis and mechanism of LDH are very complex. It is not only the result of the combined action of internal and external factors but also the participation of anatomical factors and physical and chemical factors [31]. Moreover, different factors may also influence each other at different stages. The internal cause of intervertebral disc herniation is its own degenerative changes. The degeneration of the nucleus pulposus is mainly manifested in the reduction of water content and can cause small-scale pathological changes such as vertebral instability, dislocation, and loosening, the degeneration of the annulus fibrosus. The change is mainly manifested as a decrease in toughness. There are many external factors that cause the disease. On the one hand, it may be a long-term repeated chronic cumulative damage. In addition, it may also have suffered from overloaded external force injury and aggravated or induced annulus fibrosus, leading to rupture of the annulus fibrosus, which may lead to reduced elasticity of the nucleus pulposus to pass through the annulus fibrosus, compressing the cauda equina and lumbosacral nerve roots and suffering from this disease. The mechanism research of manual therapy for

Study or subgroup	Pre-op Mean	Pre-op SD	Pre-op Total	Post-op Mean	Post-op SD	Post-op Total	Weight	Std. mean difference IV, Random, 95% CI
Gao 2020	75.76	8.11	123	15.83	4.97	123	19.7%	8.88 [8.05, 9.71]
Hamawandi 2020	9.63	0.49	30	0	0	30		Not estimable
Jiang 2018	3.9	2.1	120	1.5	1.4	120	20.3%	1.34 [1.06, 1.62]
Li 2019	7.7	1.9	35	2	1.1	35	19.8%	3.63 [2.85, 4.41]
Qu 2017	7.6	0.9	16	7.6	0.9	16	19.9%	0.00 [−0.69, 0.69]
Takahashi 2021	46.9	34	65	12.3	19	65	20.2%	1.25 [0.87, 1.63]
Total (95% CI)			389			389	100.0%	3.00 [0.92, 5.08]

Heterogeneity: $tau^2 = 5.52$; $chi^2 = 345.69$; $df = 4$ ($P < 0.00001$); $I^2 = 99\%$

Test for overall effect $Z = 2.83$ ($P = 0.005$)

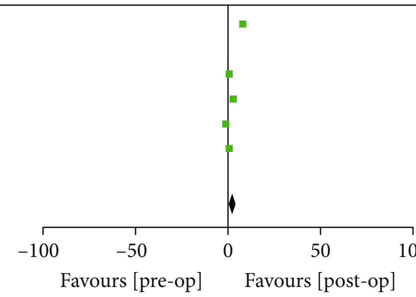

Figure 2: VAS changes before and 6 months after disc surgery.

Study or subgroup	Pre-op Mean	Pre-op SD	Pre-op Total	Post-op Mean	Post-op SD	Post-op Total	Weight	Std. mean difference IV, Random, 95% CI
Gao 2020	75.76	8.11	123	15.83	4.97	123	16.5%	8.88 [8.05, 9.71]
Hamawandi 2020	40.15	19.31	30	39.3	14.1	30	16.8%	0.05 [−0.46, 0.56]
Jiang 2018	51.7	15.4	120	13.2	5.9	120	16.9%	3.29 [2.90, 3.68]
Li 2019	64.5	17.2	35	24.7	9.5	35	16.7%	2.83 [2.16, 3.51]
Qu 2017	51.7	13.9	16	14.4	6.3	16	16.1%	3.37 [2.25, 4.49]
Takahashi 2021	51.2	20.2	65	12.3	19	65	16.9%	1.97 [1.55, 2.39]
Total (95% CI)			389			389	100.0%	3.38 [1.48, 5.28]

Heterogeneity: $tau^2 = 5.52$; $chi^2 = 340.31$; $df = 5$ ($P < 0.00001$); $I^2 = 99\%$

Test for overall effect $Z = 3.49$ ($P = 0.0005$)

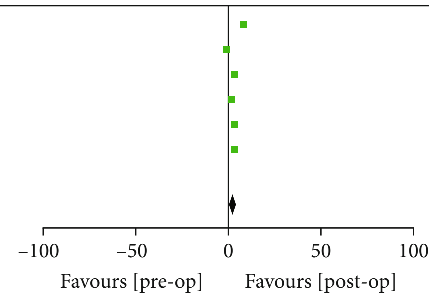

Figure 3: ODI changes before and 6 months after disc surgery.

Study or subgroup	Pre-op Mean	Pre-op SD	Pre-op Total	Post-op Mean	Post-op SD	Post-op Total	Weight	Std. mean difference IV, Random, 95% CI
Jiang 2018	15.1	4.6	120	26.7	2.9	120	66.5%	−3.01 [−3.38, −2.64]
Qu 2017	15	1	16	24.1	2.9	16	33.5%	−4.09 [−5.36, −2.81]
Total (95% CI)			136			136	100.0%	−3.37 [−4.37, −2.37]

Heterogeneity: $tau^2 = 0.36$; $chi^2 = 2.55$; $df = 1$ ($P = 0.11$); $I^2 = 61\%$

Test for overall effect $Z = 6.60$ ($P < 0.00001$)

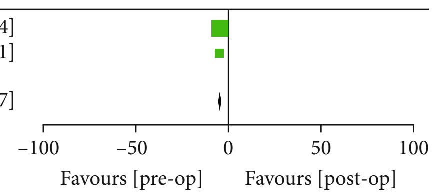

Figure 4: JOA changes before and 6 months after disc surgery.

Study or subgroup	I-II Events	I-II Total	III-V Events	III-V Total	Weight	Odds ratio M-H, Random, 95% CI
Gao 2020	24	123	62	123	14.9%	0.24 [0.14, 0.42]
Jia 2021	55	320	270	320	15.0%	0.04 [0.03, 0.06]
Jiang 2018	10	120	111	120	14.5%	0.01 [0.00, 0.02]
Kienzler 2020	2	267	253	267	13.7%	0.00 [0.00, 0.00]
Li 2021	24	1529	1342	1529	15.0%	0.00 [0.00, 0.00]
Qu 2017	12	16	4	16	13.5%	9.00 [1.82, 44.59]
Takahashi 2021	2	65	60	65	13.4%	0.00 [0.00, 0.01]
Total (95% CI)		2440		2440	100.0%	0.02 [0.00, 0.13]
Total events	129		2102			

Heterogeneity: $tau^2 = 5.76$; $chi^2 = 273.51$; $df = 6$ ($P < 0.00001$); $I^2 = 98\%$

Test for overall effect $Z = 4.18$ ($P < 0.0001$)

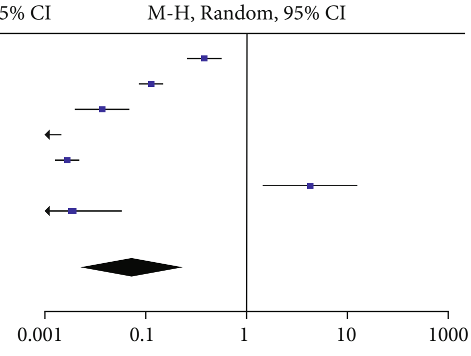

Figure 5: Forest blot of Pfirrmann grades of lumbar disc degeneration.

LDH has also been carried out around its pathogenesis. By promoting the traction of the intervertebral disc and nucleus pulposus, it can relieve spinal cord and nerve root spinous process compression, so as to achieve the effect of treating LDH. With advances in imaging technology, biomechanical research, and in vivo experiments, scholars have drawn new conclusions with the help of advanced research methods. Studies [32] have confirmed that surgery can improve pain and lumbar spine mobility by regulating the immune response of LDH patients and downregulating the expression of proinflammatory factors such as IL-1β and TNF-α. Lumbar disc herniation surgery for lumbar disc herniation can not only significantly reduce postoperative incision and lumbar and leg pain, improve the recovery effect of lumbar spine function, and enhance short-term and long-term efficacy but also significantly reduce complications.

5. Conclusion

On the basis of this meta-analysis, the following conclusions are drawn:

(1) For the treatment of LDH, the lumbar disc pain index decreased significantly after surgery

(2) The lower the grade of lumbar intervertebral disc lesion, the lower the pain score and lower back pain in the postoperative follow-up

(3) Through the study of the grade of lumbar disc lesions, reducing the grade is beneficial to reduce postoperative pain, but further improvement of the curative effect needs more practice and development

With the aging of population and the rapid development of society, the number of patients with lumbar disc herniation is increasing year by year. Epidemiological studies show that the incidence of lumbar disc herniation is 2%~3%, but about 4.8% in men over 35 years of age and 2.5% in women [33]. The etiology of LDH is complex. Aging leads to progressive degenerative changes in the intervertebral disc, decreased water content in the annulus fibrosus and nucleus pulposus, and loss of flexibility in the nucleus pulposus. Disc herniation rupture, fibrosis, nucleus pulposus, and other processes can compress nerve roots, causing symptoms such as lumbago [34]. The symptoms of most LDH patients were significantly relieved by conservative treatment such as drugs and traction. However, there are still a small number of patients with severe radiculopathy, and surgical treatment is beneficial to LDH patients who have failed conservative treatment. Studies have shown good results in terms of LBP, lower limb pain (LEP), and lower limb numbness (LEN) in LDH patients treated with discectomy [35, 36]. In most of these studies, LBP was determined using traditional visual analogue scale (VAS) and Oswestry Disability Index (ODI). Therefore, the application of pain score is of great significance to evaluate the therapeutic effect of lumbar degenerative diseases, including spinal separation and lumbar spinal stenosis.

Disc degeneration is usually classified according to Pfirrmann et al. Lumbar disc degeneration is associated with breakdown of collagen and proteoglycans and decreased water content. Water loss may reflect the extent of disc degeneration, which may be indirectly reflected by changes in magnetic resonance imaging (MRI) signals. The degree of lumbar disc degeneration can be assessed by the difference of MRI signal changes. Disc degeneration can be classified on the basis of T2-weighted disc MRI findings, disc degeneration is assessed by relative signal strength of the nucleus pulposus, and disc degeneration is assessed by the MRI signal score [37].

In conclusion, the pain scores evaluated after lumbar disc resection were lower than those before surgery, and the higher the grade of disc degeneration, the higher the pain scores were. By studying the reduction of the grade of lumbar intervertebral disc disease, it is beneficial to relieve postoperative pain and provide some scientific basis for the treatment of intervertebral disc disease.

The limitations of this study are as follows: Considering the long-term and stable pain index after surgery, the conclusions of this study need to be verified by more clinical studies with large samples and in strict accordance with the principles of randomized controlled trials. The small number of randomized controlled trials included in this study may make the statistical results less robust. In addition, language constraints may have contributed to selection bias, as this study included only English language literature. Second, metaregression analyses describe the observed relationships between experiments, as comparing study-level characteristics does not have the advantage of randomization to support a causal interpretation of the results. Thus, the associations between trial-level characteristics and intervention effects, such as bias due to unmeasured confounding factors, are the same as those found in observational studies. Third, there is a lack of structured protocols included in the studies to measure. Finally, there was substantial heterogeneity among studies due to large differences in follow-up time and no routine discussion of age and level of surgery.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] J. N. Katz, "Lumbar disc disorders and low-back pain: socioeconomic factors and consequences," *The Journal of Bone and Joint Surgery. American Volume*, vol. 88, Supplement 2, pp. 21–24, 2006.

[2] G. B. Andersson, "Epidemiology of low back pain," *Acta Orthopaedica Scandinavica Supplementum*, vol. 281, no. -sup281, pp. 28–31, 1998.

[3] L. M. Benneker, P. F. Heini, S. E. Anderson, M. Alini, and K. Ito, "Correlation of radiographic and MRI parameters to morphological and biochemical assessment of intervertebral

disc degeneration," *European Spine Journal*, vol. 14, no. 1, pp. 27–35, 2005.

[4] D. Hoy, C. Bain, G. Williams et al., "A systematic review of the global prevalence of low back pain," *Arthritis and Rheumatism*, vol. 64, no. 6, pp. 2028–2037, 2012.

[5] D. Hoy, P. Brooks, F. Blyth, and R. Buchbinder, "The epidemiology of low back pain," *Best Practice & Research. Clinical Rheumatology*, vol. 24, no. 6, pp. 769–781, 2010.

[6] C. O. Schmidt, H. Raspe, M. Pfingsten et al., "Back pain in the German adult population: prevalence, severity, and sociodemographic correlates in a multiregional survey," *Spine (Phila Pa 1976)*, vol. 32, no. 18, pp. 2005–2011, 2007.

[7] H. Paajanen, M. Erkintalo, R. Parkkola, J. Salminen, and M. Kormano, "Age-dependent correlation of low-back pain and lumbar disc regeneration," *Archives of Orthopaedic and Trauma Surgery*, vol. 116, no. 1-2, pp. 106-107, 1997.

[8] J. J. Salminen, M. O. Erkintalo, J. Pentti, A. Oksanen, and M. J. Kormano, "Recurrent low back pain and early disc degeneration in the young," *Spine*, vol. 24, no. 13, pp. 1316–1321, 1999.

[9] F. Taher, D. Essig, D. R. Lebl et al., "Lumbar degenerative disc disease: current and future concepts of diagnosis and management," *Advances in Orthopedics*, vol. 2012, Article ID 970752, 7 pages, 2012.

[10] M. Oprea, I. Popa, A. M. Cimpean, M. Raica, and D. V. Poenaru, "Microscopic assessment of degenerated intervertebral disc: clinical implications and possible therapeutic challenge," *In Vivo*, vol. 29, no. 1, pp. 95–102, 2015.

[11] M. T. Modic, T. J. Masaryk, J. S. Ross, and J. R. Carter, "Imaging of degenerative disk disease," *Radiology*, vol. 168, no. 1, pp. 177–186, 1988.

[12] R. H. Pearce, J. P. Thompson, G. M. Bebault, and B. Flak, "Magnetic resonance imaging reflects the chemical changes of aging degeneration in the human intervertebral disk," *The Journal of Rheumatology*, vol. 27, pp. 42-43, 1991.

[13] J. P. Urban and J. F. McMullin, "Swelling pressure of the lumbar intervertebral discs: influence of age, spinal level, composition, and degeneration," *Spine*, vol. 13, no. 2, pp. 179–187, 1988.

[14] J. Zou, H. Yang, M. Miyazaki et al., "Dynamic bulging of intervertebral discs in the degenerative lumbar spine," *Spine*, vol. 34, no. 23, pp. 2545–2550, 2009.

[15] C. Pfirrmann, A. Metzdorf, M. Zanetti, J. Hodler, and N. Boos, "Magnetic resonance classification of lumbar intervertebral disc degeneration," *Spine*, vol. 26, no. 17, pp. 1873–1878, 2001.

[16] M. Hangai, K. Kaneoka, S. Kuno et al., "Factors associated with lumbar intervertebral disc degeneration in the elderly," *The Spine Journal*, vol. 8, no. 5, pp. 732–740, 2008.

[17] A. Rogerson, J. Aidlen, and L. G. Jenis, "Persistent radiculopathy after surgical treatment for lumbar disc herniation: causes and treatment options," *International Orthopaedics*, vol. 43, no. 4, pp. 969–973, 2019.

[18] T. Benzakour, V. Igoumenou, A. F. Mavrogenis, and A. Benzakour, "Current concepts for lumbar disc herniation," *International Orthopaedics*, vol. 43, no. 4, pp. 841–851, 2019.

[19] J. P. T. Higgins, D. G. Altman, P. C. Gotzsche et al., "The Cochrane Collaboration's tool for assessing risk of bias in randomised trials," *BMJ*, vol. 343, no. oct18 2, p. d5928, 2011.

[20] G. H. Guyatt, A. D. Oxman, G. E. Vist et al., "GRADE an emerging consensus on rating quality of evidence and strength of recommendations," *BMJ*, vol. 336, no. 7650, pp. 924–926, 2008.

[21] M. K. Drew and C. F. Finch, "The relationship between training load and injury, illness and soreness: a systematic and literature review," *Sports Medicine*, vol. 46, no. 6, pp. 861–883, 2016.

[22] H. Takahashi, Y. Aoki, M. Inoue et al., "Characteristics of relief and residual low back pain after discectomy in patients with lumbar disc herniation: analysis using a detailed visual analog scale," *BMC Musculoskeletal Disorders*, vol. 22, no. 1, p. 167, 2021.

[23] X. Jiang, X. Zhou, and N. Xu, "Clinical effects of transforaminal and interlaminar percutaneous endoscopic discectomy for lumbar disc herniation: a retrospective study," *Medicine (Baltimore)*, vol. 97, no. 48, article e13417, 2018.

[24] Y. Qu, M. Cheng, R. Dong, M. Kang, H. Zhou, and J. Zhao, "K-rod dynamic internal fixation versus microendoscopic discectomy for the treatment of single-segment lumbar disc herniation," *Journal of Orthopaedic Surgery (Hong Kong)*, vol. 25, no. 3, p. 2309499017742740, 2017.

[25] J. C. Kienzler, J. Fandino, E. Van de Kelft, S. Eustacchio, and G. J. Bouma, "Risk factors for early reherniation after lumbar discectomy with or without annular closure: results of a multicenter randomized controlled study," *Acta Neurochirurgica*, vol. 163, no. 1, pp. 259–268, 2021.

[26] X. Gao, K. Tang, Y. Xia et al., "Efficacy analysis of percutaneous endoscopic lumbar discectomy combined with PEEK rods for giant lumbar disc herniation: a randomized controlled study," *Pain Research & Management*, vol. 2020, article 3401605, 8 pages, 2020.

[27] Y. Li, B. Wang, H. Li et al., "Adjuvant surgical decision-making system for lumbar intervertebral disc herniation after percutaneous endoscopic lumber discectomy: a retrospective nonlinear multiple logistic regression prediction model based on a large sample," *The Spine Journal*, vol. 21, no. 12, pp. 2035–2048, 2021.

[28] K. Li, K. Gao, T. Zhang, and C.-l. Lv, "Comparison of percutaneous transforaminal endoscopic lumbar discectomy through unilateral versus bilateral approach for L3/4 or L4/5 lumbar disc herniation with bilateral symptoms: technical notes and a prospective randomized study," *European Spine Journal*, vol. 29, no. 7, pp. 1724–1732, 2020.

[29] S. A. Hamawandi, I. I. Sulaiman, and A. K. Al-Humairi, "Open fenestration discectomy versus microscopic fenestration discectomy for lumbar disc herniation: a randomized controlled trial," *BMC Musculoskeletal Disorders*, vol. 21, no. 1, p. 384, 2020.

[30] M. Jia, Y. Sheng, G. Chen et al., "Development and validation of a nomogram predicting the risk of recurrent lumbar disk herniation within 6 months after percutaneous endoscopic lumbar discectomy," *Journal of Orthopaedic Surgery and Research*, vol. 16, no. 1, p. 274, 2021.

[31] L. F. Lao, G. B. Zhong, Q. Y. Li, and Z. D. Liu, "Kinetic magnetic resonance imaging analysis of spinal degeneration: a systematic review," *Orthopaedic Surgery*, vol. 6, no. 4, pp. 294–299, 2014.

[32] N. Djuric, G. C. M. Lafeber, and C. L. A. Vleggeert-Lankamp, "The contradictory effect of macrophage-related cytokine expression in lumbar disc herniations: a systematic review," *European Spine Journal*, vol. 29, no. 7, pp. 1649–1659, 2020.

[33] D. R. Eyre and H. Muir, "Collagen polymorphism: two molecular species in pig intervertebral disc," *FEBS Letters*, vol. 42, no. 2, pp. 192–196, 1974.

[34] H. Takano, I. Yonezawa, T. Okuda, and K. Kaneko, “Classification of intervertebral disc degeneration in low back pain using diffusional kurtosis imaging,” *Radiology*, vol. 10, no. 2, pp. 79–89, 2020.

[35] T. Toyone, T. Tanaka, D. Kato, and R. Kaneyama, “Low-back pain following surgery for lumbar disc herniation,” *The Journal of Bone and Joint Surgery. American Volume*, vol. 86, no. 5, pp. 893–896, 2004.

[36] S. L. Parker, S. K. Mendenhall, S. S. Godil et al., “Incidence of low back pain after lumbar discectomy for herniated disc and its effect on patient-reported outcomes,” *Clinical Orthopaedics and Related Research*, vol. 473, no. 6, pp. 1988–1999, 2015.

[37] H. Takahashi, Y. Aoki, J. Saito et al., “Unilateral laminectomy for bilateral decompression improves low back pain while standing equally on both sides in patients with lumbar canal stenosis: analysis using a detailed visual analogue scale,” *BMC Musculoskeletal Disorders*, vol. 20, no. 1, p. 100, 2019.