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Comparative analysis of percutaneous endoscopic lumbar discectomy and microdiscectomy: Outcomes in lumbar disc herniation treatment with post-operative use of analgesics and NSAIDs

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Abstract: **Background**: Percutaneous endoscopic lumbar discectomy (PELD) and microdiscectomy (MD) are both minimally invasive for lumbar disc herniation (LDH); the differential efficacy of analgesics and NSAIDs after these two surgeries requires further clarification. **Objective**: This study aimed to compare and evaluate the efficacy of analgesics and NSAIDs after PELD and MD. **Methods**: A retrospective study (Jan 2022-Jun 2024) enrolled 232 LDH patients; 211 were retained after screening and divided into Group A (PELD, n=109) and Group B (MD, n=102). Primary indicators included VAS, ODI and inflammatory factors IL-6, IL-8, TNF-α; secondary indicators included hospital stay, LANSS score, modified MacNab criteria evaluation and postoperative complications. **Results**: At 2 weeks postoperatively, Group A had significantly lower VAS, ODI, IL-6, TNF-α, IL-8 and LANSS scores (P=0.035; 0.008; 0.01; 0.038; 0.017; 0.021), while no significant differences were observed at 3 months and 1 year postoperatively between the two groups (all P>0.05). Shorter hospital stays and fewer wound complications in Group A (P=0.023; 0.04). One year postoperatively, no significant differences were observed in the modified MacNab excellent-good rate or the incidence of postoperative complications between the two groups (all P>0.05). **Conclusion**: Pregabalin and celecoxib administered after PELD/MD were effective and safe for LDH patients. PELD achieved better short-term outcomes, with no significant difference during 1-year follow-up.

Keywords: Celecoxib; Microdiscectomy; Pregabalin; Percutaneous endoscopic lumbar discectomy

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INTRODUCTION

Lumbar disc herniation (LDH) is a prevalent and frequently encountered clinical condition, which often occurs in adults. Relevant foreign studies have shown that the morbidity of LDH is approximately 2%-3%, whereas the morbidity stands at approximately 4.8% among males over 35 and 2.5% among females (Shen *et al.*, 2023).

LDH treatment encompasses both non-surgical and surgical approaches (Yu *et al.*, 2022, Takeuchi *et al.*, 2022). Surgical approaches encompass traditional open discectomy, minimally invasive discectomy and lumbar artificial disc replacement (Wang *et al.*, 2023). Percutaneous endoscopic lumbar discectomy (PELD) and micro discectomy (MD) are two minimally invasive techniques widely used at present. PELD performs the operation under a high-definition visual environment through a small incision on the skin using an endoscope to remove the herniated intervertebral disc. MD uses an operating microscope to magnify and observe the anatomical structures in the operating area, more conducive to gentle, safe and precise operation around nerves (Gadjradj *et al.*, 2022).

Both PELD and MD can lead to postoperative pain. Non-steroidal anti-inflammatory drugs (NSAIDs) stand as the most widely used and core medications. Among them, celecoxib functions as a selective cyclooxygenase-2 (COX-2) inhibitor, mainly used to relieve osteoarthritis, rheumatoid arthritis, ankylosing spondylitis and acute pain.A meta-analysis undertaken by Silvia Gianola *et al* (Gianola *et al.*, 2022) showed that NSAIDs combined with other analgesic drugs can reduce pain in patients with acute or subacute non-specific lumbago (*SMD*: 0.53; *95%CI*: -0.97--0.09). NSAIDs can be combined with weak opioids such as tramadol, simple analgesic drugs such as paracetamol and neuropathic pain drugs such as pregabalin, all of which have achieved good results (Ma *et al.*, 2024). Among them, the combined application of celecoxib and pregabalin is a new idea and new method.

While studies have explored different NSAIDs in LDH patients, none comprehensively compared PELD and MD. Addressing this gap, this retrospective comparative study analyzed efficacy in LDH patients receiving postoperative celecoxib and pregabalin, aiming to compare PELD vs. MD outcomes. It seeks to provide more effective, personalized treatment plans for patients and reference for advancing spinal surgery and combined medication.

MATERIALS AND METHODS

General information

This study retrospectively enrolled 232 LDH patients (Jan 2022-Jun 2024) to compare analgesic/NSAID efficacy after PELD and MD. 232 were initially collected; 220 remained post-exclusion, with 5 lost to follow-up and 4 withdrawing. Finally, 211 patients were analyzed (Fig. 1).

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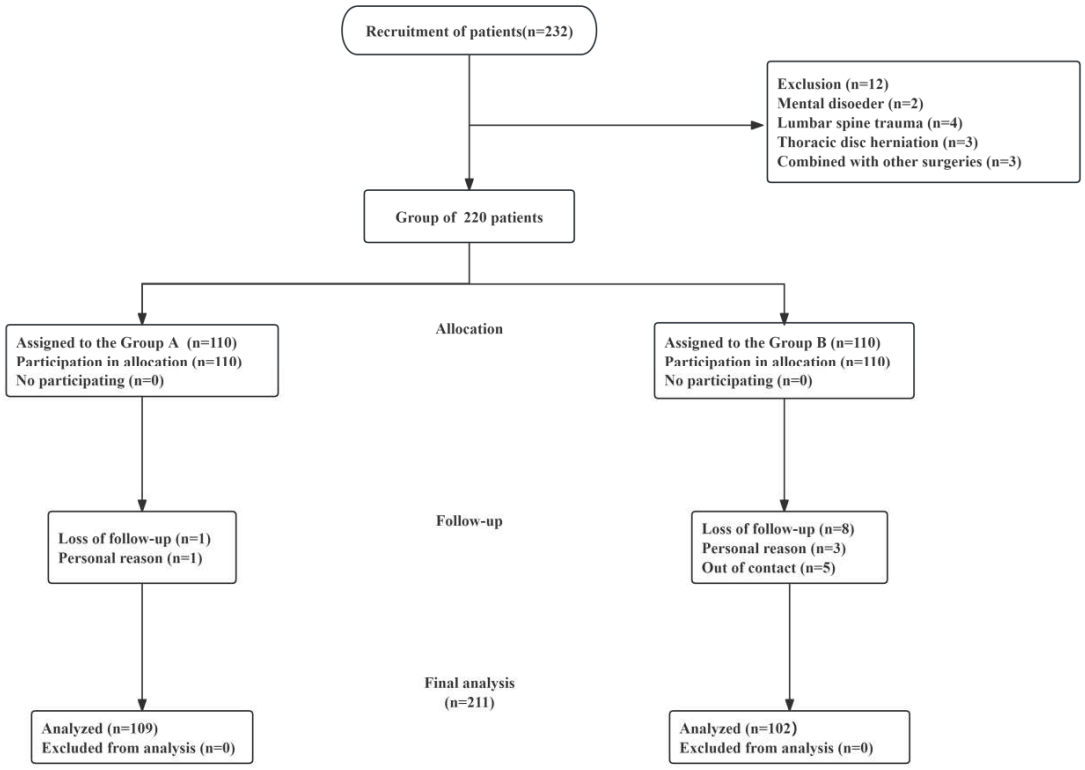

Fig. 1: Experimental process design diagram
(The flowchart outlines the recruitment, inclusion, exclusion and allocation of patients. Eventually, a total of 109 patients of the Group A and 102 patients of the Group B were obtained for analysis and comparison).

Inclusion criteria

(1) Meeting the diagnostic criteria for LDH in the "Guidelines for Diagnosis, Treatment and Rehabilitation Management of Lumbar Disc Herniation"(Basic Research and Translational Medicine Group of the Spine and Spinal Cord Professional Committee, 2022); (2) Having not undergone LDH surgery; (3) Aged > 18 years; (4) Clinical evaluation indicating that the surgical method is PELD or MD; (5) Complete clinical data and related examinations.

Exclusion criteria

(1) Individuals with mental illness or cognitive dysfunction; (2) Having lumbar trauma; (3) Requiring combination with other surgeries; (4) Disc herniation with calcification; (5) Thoracic disc herniation; (6) Patients with drug allergy and those with other drug contraindications (Gadjradj *et al.*, 2021, Jiang *et al.*, 2022).

Follow-up protocol

1-year postoperative follow-up started the day after surgery with a 12-month period (cut-off: June 31, 2025) and follow-up at 2 weeks, 3 and 12 months. Patients lost to 12-month follow-up were censored at last visit(Yu *et al.*, 2021).

Treatment methods

The same postoperative analgesic medication regimen was adopted, namely combined treatment with celecoxib and pregabalin. The medication regimen was to administer celecoxib capsules (Pfizer Inc.; National Drug Approval Number J20030099), celecoxib was taken orally twice a day, 200 mg each time, within 14 days after surgery; Pregabalin Capsule (Pfizer Inc.; National Drug Approval Number HJ20150620), pregabalin was taken orally three times a day, 150 mg each time, within 10 days after surgery; from day 11 to day 14 after surgery, it was taken three times a day, 75 mg each time and the medication was continued for 2 weeks (Xie *et al.*, 2022, Yang *et al.*, 2024).

Observation indicators

Primary observation indicators

Visual analogue scale (VAS)

Widely employed as a tool, the VAS score is used for quantifying pain levels. The score ranges from 0 to 10, with a higher score indicating more severe pain (Albert *et al.*, 2024, Wang *et al.*, 2022).

Oswestry disability index (ODI)

ODI is a standardized tool for assessing the degree of dysfunction in patients with lumbago, with an aggregate score of 100, whereby higher scores correspond to greater severity of dysfunction (Wang *et al.*, 2022).

Level of inflammatory factors

Tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6) and interleukin-8 (IL-8) were measured using enzyme-linked immunosorbent assay (ELISA) kits.

Secondary outcome measures

Length of hospital stay

The number of calendar days from admission to discharge constitutes the length of hospital stay and data are extracted from the hospital electronic medical record system (Ito *et al.*, 2023).

Leeds assessment of neuropathic symptoms and signs (LANSS)

The LANSS scale serves to screen for neuropathic pain. The maximum score is 24 scores. The higher the score, the more severe the neuropathic pain (Saghaeian *et al.*, 2022).

Modified MacNab criteria

The modified MacNab criteria evaluation are as follows: Excellent: symptoms completely disappear and original work and life are resumed; Good: slight symptoms, mild restriction in activity, no impact on work and life; Fair: symptoms are alleviated, activity is limited, affecting normal work and life; Poor: no difference before and after treatment, or even worse (Zhu *et al.*, 2022).

Postoperative complication rate

Complications included nerve root injury, transient neuralgia, wound complications, recurrence, etc.(Yu *et al.*, 2021)

Sample size calculation method

Sample size was calculated via G*Power 3.1.9.7 based on VAS scores. Referring to Yi Zhou *et al*.'s (Zhou *et al.*, 2023) study (effect size = 0.57), an independent samples t-test (α=0.05, two-tailed, 95% power) estimated 81 patients per group. Considering potential uncertainties, 211 patients were finally included, which ensures reliable conclusions.

Statistical analysis

Data were analyzed via SPSS 28.0. Normally distributed data (expressed as $\bar{x}\pm s$) were tested by independent samples t-test; categorical count data [expressed as n(%)] were compared between groups using chi-square test. All tests were two-tailed, with $P<0.05$ denoting statistical significance.

RESULTS

Comparison of baseline data between the two groups

Between the two groups, no statistically significant differences came to light in baseline data (all $P>0.05$), indicating that the two groups of patients were comparable before surgery. (Table 1)

Comparison of VAS scores between the two groups of patients

Analysis at two weeks, three months and one year after surgery showed that at two weeks after surgery, the VAS score of Group B proved to be notably higher than Group A's ($P=0.035$). At 3 months and 1 year following surgery, the two groups showed no notable disparity ($P=0.513$; $P=0.905$) (Table 2). PELD has a better effect in reducing patients' pain in the early post-surgical period.

Comparison of ODI scores between the two groups of patients

Two weeks post-surgery, when set against Group A's ODI score, the ODI score of Group B significantly increased ($P=0.008$). No significant discrepancies emerged between 3 months and 1 year post-surgery ($P=0.108$; $P=0.731$) (Table 3). The results showed that PELD had a better quality of life than MD in the early postoperative period.

Comparison of inflammatory factors IL-6, IL-8 and TNF-α between the two groups of patients

At two weeks after surgery, compared with the IL-6, TNF-α and IL-8 levels in Group A, the three inflammatory indicators in Group B increased ($P=0.01$; $P=0.038$; $P=0.017$). No significant discrepancies were observed at 3 months and 1 year postoperatively, when comparing the two groups ($P=0.602$, 0.871; $P=0.370$, 0.136; $P=0.132$, 0.064). PELD reduced the inflammatory response faster than MD in the early postoperative period. (Table 4)

Comparison of the length of hospital stay between the two groups of patients

See table 5, Group A patients had a hospital stay lasting 4.00±1.66 days. Group B was 4.50±1.49 days. Group B's length of hospital stay was markedly lengthened ($P=0.023$). The observations demonstrated that PELD resulted in a shorter hospitalization time than MD.

Comparison of LANSS scores between the two groups of patients

Two weeks postoperatively, when compared with Group A, the LANSS score of Group B was notably elevated ($P=0.021$). No notable discrepancy was found between 3 months and 1 year after surgery ($P=0.731$; $P=0.731$). The results showed that PELD had a more obvious pain relief effect than MD in the early postoperative period. (Table 6)

Comparison of modified MacNab criteria evaluation between the two groups of patients

In Group A, an excellent and good rate reaching 89.9%. an excellent and good rate in Group B of 91.2%. It can be seen that no notable discrepancy in clinical outcomes as regards the two groups within one year ($P=0.989$). (Table 7)

Comparison of postoperative complications between the two groups of patients

As shown in table 8, Group A had significantly lower wound complications ($P=0.04$). No significant difference was observed in overall postoperative complications between the two groups ($P=0.212$).

Table 1: Baseline characteristics [$\overline{x}\pm s$, *n* (%)]

Variables	Group A (n=109)	Group B (n=102)	95%CI		*P*	Effect size
			Lower	*Upper*		
Age (years)	58.12±9.76	56.98±10.62	-1.63	3.91	0.418	0.11
BMI(kg/m^2)	23.73±1.71	23.74±1.66	-0.47	0.45	0.973	-0.01
Gender						
Male	59(54.1)	54(52.9)	0.61	1.80	0.863	0.012
Female	50(45.9)	48(47.1)				
Affected level						
L4/5	43(39.4)	40(39.2)				
L5/S1	42(38.5)	41(40.2)	-	-	0.957	0.020
L4/5 merging L5/S1	24(22.1)	21(20.6)				
Smoking	45(41.3)	42(41.2)	0.58	1.74	0.987	0.001
Diabetes mellitus	21(19.3)	19(18.6)	0.52	2.08	0.906	0.008
Drinking	41(37.6)	42(41.2)	0.5	1.5	0.597	-0.04
Course of disease (months)	15.06±6.55	15.22±6.76	-1.97	1.65	0.861	-0.02

Note: BMI: Body mass index.

Table 2: Comparison of VAS scores of patients ($\overline{x}\pm s$，scores)

Variables		VAS			
Time		Before surgery	2 weeks after surgery	3 months after surgery	1 year after surgery
Group A(n=109)		7.00±1.66	2.00±1.19*	1.53±1.02*	1.39±1.02*
Group B(n=102)		6.92±1.65	2.35±1.22*	1.44±0.99*	1.40±1.00*
95%CI	*Lower*	-0.37	-0.68	-0.18	-0.29
	Upper	0.53	-0.03	0.36	0.26
P		0.731	0.035	0.513	0.905
Effect size		0.05	-0.29	0.09	-0.01

Note: **P*<0.05 vs Before treatment; VAS: Visual analogue scale.

Table 3: Comparison of ODI scores of patients ($\overline{x}\pm s$，scores)

Variables		ODI			
Time		Before surgery	2 weeks after surgery	3 months after surgery	1 year after surgery
Group A(n=109)		68.12±9.76	20.29±9.44*	13.72±8.78*	7.00±1.66*
Group B(n=102)		66.98±10.62	23.98±10.62*	15.75±9.39*	6.92±1.65*
95%CI	*Lower*	-1.63	-6.41	-4.49	-0.37
	Upper	3.91	-0.96	0.45	0.53
P		0.418	0.008	0.108	0.731
Effect size		0.11	-0.37	-0.22	0.05

Note: **P*<0.05 vs Before treatment; ODI: Oswestry disability index.

DISCUSSION

Postoperative pain management is crucial for both PELD and MD, as it is closely linked to patient recovery. Piet Waelkens (Waelkens *et al.*, 2021) conducted a meta-analysis of 111 spinal surgery studies, confirming the need for NSAIDs combined with other analgesics in post-spinal surgery patients. Zhaojun Song *et al.*'s (Song *et al.*, 2021) follow-up of 267 LDH patients showed reduced postoperative pain in both PELD and MD groups, consistent with this study-here, PELD patients also had more significant reductions in VAS, inflammatory factors, ODI and LANSS scores than MD patients in the early postoperative period (2 weeks post-surgery). For LDH patients, nerve roots are long-term compressed by herniated nucleus pulposus tissue; injury stimuli from compression-induced local aseptic inflammation and immune response are continuously transmitted and those with a long disease course may have preoperative peripheral or central sensitization (Albert *et al.*, 2024). In PELD, three factors (prolonged contact between endoscopic working channel and nerve root, potential traction/compression from extra-channel nerve root block and radiofrequency electrode-induced nerve root stimulation) cause continuous afferent nerve electrical stimulation, accelerating central sensitization (He *et al.*, 2023, Ma *et al.*, 2022).

Table 4: Comparison of TNF-α/IL-6/IL-8 of patients ($\bar{x}\pm s$, ng/L)

Variables	Time	Group A (n=109)	Group B (n=102)	95%CI		*P*	*Effect size*
				Lower	*Upper*		
IL-6	Before surgery	41.51±3.21	41.78±3.30	-1.15	0.62	0.555	-0.08
	2 weeks after surgery	23.08±1.79*	23.74±1.93*	-1.17	-0.16	0.01	-0.35
	3 months after surgery	17.86±1.77*	17.74±1.82*	-0.36	0.62	0.602	0.07
	1 year after surgery	17.26±1.83*	17.22±1.79*	-0.45	0.53	0.871	0.02
TNF-α	Before surgery	149.99±9.07	149.63±9.28	-2.13	2.85	0.775	0.04
	2 weeks after surgery	116.48±9.59*	119.11±8.61*	-5.11	-0.15	0.038	-0.29
	3 months after surgery	110.44±9.44*	111.57±8.65*	-3.59	1.34	0.370	-0.12
	1 year after surgery	97.48±9.59*	99.36±8.53*	-4.34	0.59	0.136	-0.21
IL-8	Before surgery	65.65±3.92	66.10±4.40	-1.58	0.68	0.437	-0.11
	2 weeks after surgery	41.42±3.30*	42.48±3.08*	-1.92	-0.19	0.017	-0.33
	3 months after surgery	33.68±3.81*	34.45±3.58*	-1.78	0.23	0.132	-0.21
	1 year after surgery	30.96±3.62*	31.86±3.44*	-1.87	0.05	0.064	-0.25

Note: *P<0.05 vs Before treatment; TNF-α: Tumor necrosis factor-α; IL-6: Interleukin-6; IL-8: Interleukin-8.

Table 5: Comparison of the length of hospital stay of patients ($\bar{x}\pm s$，days)

Variables	Group A (n=109)	Group B (n=102)	*95%CI*		*P*	*Effect size*
			Lower	*Upper*		
The length of hospital stay	4.00±1.66	4.50±1.49	-0.93	-0.07	0.023	The length of hospital stay

Table 6: Comparison of LANSS scores of patients ($\bar{x}\pm s$，scores)

Variables		LANSS			
Time		Before surgery	2 weeks after surgery	3 months after surgery	1 year after surgery
Group A(n=109)		11.00±1.66	7.98±1.65*	6±1.66*	4.00±1.66*
Group B(n=102)		10.92±1.65	8.51±1.66*	5.92±1.65*	3.92±1.65*
95%CI	*Lower*	-0.37	-0.98	-0.37	-0.37
	Upper	0.53	-0.08	0.53	0.53
P		0.731	0.021	0.731	0.731
Effect size		0.05	-0.32	0.05	0.05

Note: *P<0.05 vs Before treatment; LANSS: Leeds assessment of neuropathic symptoms and signs.

Table 7: Comparison of modified MacNab criteria of patients [*n* (%)]

Variables	Modified MacNab criteria [*n* (%)]				
	Excellent	Good	Fair	Poor	Rate (excellent and good)
Group A(n=109)	54(49.5)	44(40.4)	7(6.4)	4(3.7)	98 (89.9)
Group B(n=102)	51(50)	42(41.2)	6(5.9)	3(2.9)	93 (91.2)
Test			Chi-Square Test		
P			0.989		

Table 8: Comparison of postoperative complications of patients [*n* (%)]

Variables		Postoperative complications [*n* (%)]				
		Nerve root injury	Transient hyperalgesia	Wound complications	Recurrence	Total
Group A (n=109)		5(4.6)	4(3.7)	2(1.8)	10(9.2)	21 (19.3)
Group B (n=102)		3(2.9)	5(4.9)	8(7.8)	11(10.8)	27 (26.5)
95CI%	*Lower*	0.37	0.19	0.05	0.34	0.35
	Upper	6.82	2.83	1.06	2.06	1.27
P		0.532	0.658	0.04	0.696	0.212
Effect size		0.043	-0.03	-0.14	-0.03	-0.09

MD is essentially similar to open surgery, differing only in performing operations (partial removal of ligamentum flavum, lamina and articular process, neural foramen enlargement, perineural adhesion release, discectomy) under a microscope. As a minimally invasive, endoscopic open surgery variant, it also affects nerve roots intraoperatively; though it causes less damage to spinal stability structures, its advantage over conventional open surgery is limited (Kong *et al.*, 2023). Multiple studies (Yu *et al.*, 2021, Zhang *et al.*, 2023) note PELD has fewer incisions, less bleeding and less trauma than MD. For these reasons, MD patients have stronger postoperative oxidative stress and inflammatory responses. Even with postoperative analgesics and NSAIDs, MD patients show slower recovery of inflammatory factors and neuropathic pain responses than PELD patients.

Lu Mao *et al*.'s retrospective analysis (Mao *et al.*, 2025) showed no difference in excellent/good rates between MD and PELD (82.35% vs. 87.5%), consistent with this study's outcomes. PELD causes less damage to paravertebral blood vessels, nerves, muscles and related tissues, which helps preserve spinal biomechanical stability-key for postoperative lumbar function recovery-and thus shortens hospital stays. Sijia Liu *et al*. (Liu *et al.*, 2025), analyzing 22 studies, found PELD had shorter hospital stays than MD (4.92 days vs. 6.71 days; $P<0.001$), which also matches this study's data showing shorter stays in the PELD group. Nan-Ju Lee *et al*.'s retrospective cross-sectional analysis of 383 patients (Lee *et al.*, 2021) reported similar complication rates between PELD and MD, with PELD having the smallest wound size (0.82 cm)-another alignment with this study. For postoperative complications here, MD had a higher risk of wound complications, while recurrence rates, nerve root injury and transient neuralgia showed no significant difference between the two surgeries; this is attributed to MD requiring an incision.

The innovation of this study is its focus on PELD and MD, with specific comparison of the same analgesic regimen's differential efficacy post-surgery. It resolves the limitation of prior studies, clarifies adaptation differences between different minimally invasive surgeries and a fixed combined analgesic regimen, builds a multi-dimensional, long-term efficacy evaluation system-providing comprehensive evidence and precises references for individualized treatment.

Study limitations

This is a retrospective clinical study. Though data collection and analysis were conducted by researchers not involved in patient treatment, retrospective studies have inherent limitations: the 211-sample size is relatively small and lacks coverage of groups with different economic and cultural backgrounds, potentially causing selection bias and undermining result universality and representativeness. Additionally, scales like VAS have biases-measurement tools/methods are subjective and patient self-reported data is prone to the social desirability effect. No subgroup analysis was done and no long-term follow-up, precluding understanding of the two surgeries' long-term efficacy. Future research should adopt prospective randomized controlled designs with multi-center, large samples. It should also add long-term follow-up, use stratified random design and extend safety monitoring to provide a stronger theoretical basis for clinical use.

CONCLUSION

In summary, postoperative use of analgesics and NSAIDs is effective for LDH patients undergoing either PELD or MD. In the short term, PELD outperforms MD in relieving postoperative pain, reducing inflammatory response and restoring neurological function, thereby promoting patients' rapid short-term recovery.

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None

Authors' contribution

Huanbin Zhou: Developed and planned the study, performed experiments and interpreted results. Edited and refined the manuscript with a focus on critical intellectual contributions. Participated in collecting, assessing and interpreting the data. Made significant contributions to date interpretation and manuscript preparation; Hongzhi Yang: Provided substantial intellectual input during the drafting and revision of the manuscript.

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Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval

This study was approved by JiuJiang NO.1 People's Hospital Ethics Committee (The ethical approval number: 202225).

Conflicts of interest

The authors declare that they have no conflicts of interest.

REFERENCES

Albert HB, Sayari AJ, Barajas JN, Hornung AL, Harada G, Nolte MT, Chee AV, Samartzis D and Tkachev A (2024). The impact of novel inflammation-preserving treatment towards lumbar disc herniation resorption in symptomatic patients: A prospective, multi-imaging and clinical outcomes study. *Eur. Spine J.,* **33**(3): 964-973.

Basic Research and Translational Medicine Group of the Spine and Spinal Cord Professional Committee, CaORM (2022). Guidelines for diagnosis, treatment and rehabilitation management of lumbar disc herniation. *Chin. J. Surg.,* **60**(5): 401-408.

Gadjradj PS, Harhangi BS, Amelink J, Van Susante J, Kamper S, Van Tulder M, Peul WC, Vleggeert-Lankamp C and Rubinstein SM (2021). Percutaneous transforaminal endoscopic discectomy versus open microdiscectomy for lumbar disc herniation: A systematic review and meta-analysis. *Spine (Phila. Pa. 1976),* **46**(8): 538-549.

Gadjradj PS, Rubinstein SM, Peul WC, Depauw PR, Vleggeert-Lankamp CL, Seiger A, Van Susante JL, De Boer MR, Van Tulder MW and Harhangi BS (2022). Full endoscopic versus open discectomy for sciatica: Randomised controlled non-inferiority trial. *BMJ,* **21**(376): e065846.

Gianola S, Bargeri S, Del Castillo G, Corbetta D, Turolla A, Andreano A, Moja L and Castellini G (2022). Effectiveness of treatments for acute and subacute mechanical non-specific low back pain: A systematic review with network meta-analysis. *Br. J. Sports Med.,* **56**(1): 41-50.

He D, Cheng X, Zheng S, Deng J, Cao J, Wu T and Xu Y (2023). Unilateral biportal endoscopic discectomy versus percutaneous endoscopic lumbar discectomy for lumbar disc herniation: A systematic review and meta-analysis. *World Neurosurg.,* **May**(173): e509-e520.

Ito S, Nakashima H, Sato K, Deguchi M, Matsubara Y, Kanemura T, Urasaki T, Yoshihara H, Sakai Y, Ito K, Shinjo R, Ando K, Machino M, Segi N, Tomita H, Koshimizu H and Imagama S (2023). Laterality of lumbar disc herniation. *J. Orthop. Sci.,* **28**(6): 1207-1213.

Jiang HW, Chen CD, Zhan BS, Wang YL, Tang P and Jiang XS (2022). Unilateral biportal endoscopic discectomy versus percutaneous endoscopic lumbar discectomy in the treatment of lumbar disc herniation: A retrospective study. *J. Orthop. Surg. Res.,* **17**(1): 30.

Kong L, Huang Y, Yao T and Xu HG (2023). Retrospective analysis of paraspinal muscle-splitting microscopic-assisted discectomy versus percutaneous endoscopic lumbar discectomy for the treatment of far-lateral lumbar disc herniation. *Turk. Neurosurg.,* **33**(4): 541-547.

Lee NJ, Jung SY, Park KM, Choi Y, Huh J and Park W (2021). Factors affecting root migration after coronectomy of the mandibular third molar. *Medicine (Baltimore),* **100**(20): e25974.

Liu S, Zhang X, Xiong Y and He H (2025). Minimally invasive surgery for lumbar disc herniation: A meta-analysis of efficacy and safety. *Int. J. Surg.,* **111**(8): 5623-5636.

Ma J, Bjornsson ES and Chalasani N (2024). The safe use of analgesics in patients with cirrhosis: A narrative review. *Am. J. Med.,* **137**(2): 99-106.

Ma X, Li W, Gao S, Cao C, Li C, He L and Li M (2022). Comparison of unilateral biportal endoscopic discectomy versus percutaneous endoscopic lumbar discectomy for the treatment of lumbar disc herniation: A systematic review and meta-analysis. *Medicine (Baltimore),* **101**(39): e30412.

Mao L, Shen Z, Zhu W, Wang K, Fan P, Wu X, Li L and Liu G (2025). Comparison of the efficacy of microendoscopic discectomy and percutaneous endoscopic lumbar discectomy for treating adolescent lumbar disc herniation. *Sci. Rep.,* **15**(1): 10185.

Saghaeian SM, Salavati M, Akhbari B, Ghamkhar L, Layeghi F and Kahlaee AH (2022). Persian version of the lanss and s-lanss questionnaires: A study for cultural adaptation and validation. *Appl. Neuropsychol. Adult,* **29**(5): 1095-1102.

Shen SC, Chen HC, Tsou HK, Lin RH, Shih YT, Huang CW, Tang CL, Chen HT, Chang CC and Tzeng CY (2023). Percutaneous endoscopic lumbar discectomy for l5-s1 disc herniation based on image analysis and clinical findings: A retrospective review of 345 cases. *Medicine (Baltimore),* **102**(5): e32832.

Song Z, Ran M, Luo J, Zhang K, Ye Y, Zheng J and Zhang Z (2021). Follow-up results of microendoscopic discectomy compared to day surgery using percutaneous endoscopic lumbar discectomy for the treatment of lumbar disc herniation. *BMC Musculoskelet. Disord.,* **22**(1): 160.

Takeuchi S, Hanakita J, Takahashi T, Inoue T, Minami M, Suda I, Nakamura S and Kanematsu R (2022). Predictive factors for poor outcome following chemonucleolysis with condoliase in lumbar disc herniation. *Medicina (Kaunas),* **58**(12): 1868.

Waelkens P, Alsabbagh E, Sauter A, Joshi GP, Beloeil H, Anaesthesia PWGOTESOR and Pain T (2021). Pain management after complex spine surgery: A systematic review and procedure-specific postoperative pain management recommendations. *Eur. J. Anaesthesiol.,* **38**(9): 985-994.

Wang L, Li L, Cheng C, Guo Z, Xin D, Yan X, Li W and Han H (2023). Full-endoscopic isolation zone technique for the treatment of lumbar disc herniation. *J. Vis. Exp.,* **7**(194): e65107.

Wang W, Long F, Wu X, Li S and Lin J (2022). Clinical efficacy of mechanical traction as physical therapy for lumbar disc herniation: A meta-analysis. *Comput. Math. Methods Med.,* **21**(2022): 5670303.

Xie W, Wu CJ, Li Y, Lu QL, Gan XW, Li XG and Tang J (2022). Effect analysis of sacral canal therapy combined with fufang wulingzhi tangjiang in the treatment of residual root pain after lumbar surgery. *Eur. Rev. Med. Pharmacol. Sci.,* **26**(24): 9212-9220.

Yang S, Jia Y, Zhang J, Zhai W, Xie Y and Guo J (2024). A randomized controlled trial: The efficacy and safety of bushen huoxue formula in the management of lower back pain from lumbar disc herniation. *Medicine (Baltimore),* **103**(7): e37293.

Yu P, Mao F, Chen J, Ma X, Dai Y, Liu G, Dai F and Liu J (2022). Characteristics and mechanisms of resorption in lumbar disc herniation. *Arthritis Res. Ther.,* **24**(1): 205.

Yu P, Zan P, Zhang X, Qiang H, Samsonraj RM, Tang J and Huang P (2021). Comparison of percutaneous transforaminal endoscopic discectomy and microendoscopic discectomy for the surgical management of symptomatic lumbar disc herniation: A multicenter retrospective cohort study with a minimum of 2 years' follow-up. *Pain Physician,* **24**(1): E117-E125.

Zhang C, Han JC, Wang YG, Ma WT, Zhou X, Yang G and Wang P (2023). Depression is associated with worse outcome after percutaneous endoscopic lumbar discectomy: A 5-year follow-up study. *Psychol. Health Med.,* **28**(6): 1470-1478.

Zhou Y, Liu X, Ding C, Xiang B and Yan L (2023). Positive preemptive analgesia effectiveness of pregabalin combined with celecoxib in total knee arthroplasty: A prospective controlled randomized study. *Pain Res. Manag.,* **12**(2023): 7088004.

Zhu H, Hussain Z, Zhang M, Ji F, Mao H, Li H and Chen H (2022). Percutaneous endoscopic lumbar discectomy for lumbar disc herniation with type ii modic changes. *World Neurosurg.,* **164**: e143-e149.