Journal of Pain Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Acupotomy Combined with Celecoxib and Zhenggu Shenjin Capsules for Lumbar Disc Herniation: A Propensity Score-Matched Retrospective Cohort Study

Xiuchen Sun[1], Shuaimei Zhang[2], Shuojun Liu[3]

[1]Pain Clinic, Shandong Wendeng Orthopedics Hospital, Weihai, Shandong, People's Republic of China; [2]Department of Emergency, Shandong Wendeng Orthopedics Hospital, Weihai, Shandong, People's Republic of China; [3]Department of Science and Education, Shandong Wendeng Orthopedics Hospital, Weihai, Shandong, People's Republic of China

Correspondence: Shuojun Liu, Email 13869012208@163.com

Background: Lumbar disc herniation (LDH) is a leading cause of chronic low back pain, affecting approximately 1–3% of the general population annually with substantial socioeconomic burden. Acupotomy, a minimally invasive Traditional Chinese Medicine (TCM) technique, has demonstrated promise in musculoskeletal disorders, yet large-scale evidence evaluating its combination with pharmacotherapy remains limited. This study evaluated the efficacy and safety of acupotomy combined with celecoxib and Zhenggu Shenjin capsules versus pharmacotherapy alone in patients with LDH.

Methods: This retrospective cohort study analyzed electronic medical records of 800 LDH patients treated at Shandong Wendeng Orthopedic Hospital between February 2023 and October 2024. Using 1:1 propensity score matching (PSM), patients were allocated to the experimental group (acupotomy plus celecoxib 200 mg twice daily and Zhenggu Shenjin capsules 0.99 g three times daily for 4 weeks, n=400) or the control group (celecoxib 200 mg twice daily and Zhenggu Shenjin capsules 0.99 g three times daily without acupotomy, n=400). Primary outcomes included Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) changes at 3 months post-treatment. Secondary outcomes encompassed overall efficacy rates and adverse events (AEs).

Results: Following PSM, baseline characteristics were well-balanced (all standardized mean differences <0.10). The experimental group demonstrated significantly greater VAS reduction (4.12±1.28 vs 2.68±1.15, P<0.001) and ODI improvement (22.85±8.47% vs 13.76±7.21%, P<0.001) compared to controls. Overall efficacy rate was significantly higher (78.50% vs 58.75%, P<0.001), while adverse event incidence was lower (4.25% vs 11.50%, P<0.001). Subgroup analyses showed consistent benefits across all strata, with younger patients (<50 years; P-interaction=0.042) and those with shorter symptom duration (<6 months; P-interaction=0.008) deriving greatest benefit.

Conclusion: Acupotomy combined with celecoxib and Zhenggu Shenjin capsules demonstrated superior pain relief, functional improvement, and safety profile compared to pharmacotherapy alone for LDH treatment. These findings support the integration of this regimen into clinical guidelines for non-surgical LDH management and warrant prospective validation through multicenter randomized controlled trials.

Keywords: acupotomy, lumbar disc herniation, traditional Chinese medicine, celecoxib, zhenggu shenjin capsules, propensity score matching, retrospective cohort study

Introduction

Lumbar disc herniation (LDH) represents a major cause of chronic low back pain and disability, affecting approximately 1–3% of the general population annually and imposing substantial socioeconomic burdens through healthcare expenditures and productivity losses.[1,2] Recent epidemiological data from the Global Burden of Disease Study indicate that low back pain affected 619 million individuals globally in 2020, with projections suggesting an increase to 843 million by

https://doi.org/10.2147/JPR.S594368
Received: 26 January 2026
Accepted: 26 March 2026
Published: 21 April 2026

2050.[3] The pathophysiology of LDH involves mechanical compression of neural structures by herniated nucleus pulposus, accompanied by inflammatory responses characterized by elevated pro-inflammatory cytokines including interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), and prostaglandin E2, which collectively contribute to neuropathic pain cascades.[4,5] While conventional treatments encompass nonsteroidal anti-inflammatory drugs (NSAIDs), physical therapy, and surgical intervention, many patients experience suboptimal outcomes with conservative management, and 10–20% progress to surgery despite inherent recurrence risks of 5–15%.[6,7]

Traditional Chinese Medicine (TCM) offers complementary therapeutic modalities rooted in millennia of clinical experience. According to TCM theoretical frameworks, LDH pathogenesis involves liver-kidney deficiency (gan-shen kui-xu), leading to inadequate nourishment of tendons and bones, and qi stagnation and blood stasi (qi-zhi xue-yu)s, causing meridian obstruction and pain manifestation.[8] This theoretical framework is supported by canonical TCM texts including the Su Wen and Jin Kui Yao Lue, and corroborated by modern network pharmacology analyses confirming that kidney-tonifying herbs modulate osteoclastogenesis and intervertebral disc cell survival pathways mechanistically dysregulated in LDH.[9] Acupotomy (zhen-dao liao-fa), developed by Professor Zhu Hanzhang in the 1970s, represents a hybrid technique combining acupuncture meridian principles with minimally invasive surgical precision.[10] The procedure involves percutaneous release of adhesions and decompression at specific acupoints (Ashi points) using a specialized needle-knife instrument (0.4–0.8mm diameter), targeting myofascial trigger points and restoring biomechanical balance.[11] Recent systematic reviews and meta-analyses suggest that acupotomy reduces pain by 30–50% in LDH patients, with pooled effect sizes demonstrating significant advantages over conventional treatments.[12,13]

Pharmacological augmentation may enhance acupotomy's therapeutic effects through anti-inflammatory synergy. Celecoxib, a selective cyclooxygenase-2 (COX-2) inhibitor, suppresses prostaglandin E2 synthesis and mitigates post-procedural inflammation while demonstrating superior gastrointestinal safety compared to non-selective NSAIDs.[14,15] Recent meta-analyses have confirmed celecoxib's cardiovascular safety profile, with risk ratios comparable to or lower than traditional NSAIDs.[16] Zhenggu Shenjin capsules, a proprietary hospital preparation approved under Shandong Medical Institution Preparation Standards (approval number: Z10080006), embody classical TCM formulae for tonifying iver-kidney (bu-yi gan-shen), relaxing tendons (shu-jin huo-luo), and invigorating blood circulation (huo-xue hua-yu).[17] The formulation comprises eight principal medicinal herbs including fried earthworm (Di-long, 15g), processed nux vomica (Zhi Ma-qian-zi, 10g), calcined pyrite (Duan Zi-ran-tong, 12g), Chinese taxillus herb (Sang-ji-sheng, 15g), Eucommia bark (Du-zhong, 10g), papaya (Mu-gua, 10g), Achyranthes root (Niu-xi, 10g), and safflower (Hong-hua, 8g), standardized per pharmacopoeial monographs.[18,19] Pharmacological studies have demonstrated that earthworm-derived lumbrokinase exhibits potent fibrinolytic activity, safflower flavonoids promote vasodilation and anti-inflammatory effects, while strychnine alkaloids at subtoxic concentrations (<0.6mg per capsule) modulate glycinergic neurotransmission for analgesia.[9,20] Clinically, Zhenggu Shenjin capsules have demonstrated an acceptable safety profile when strychnine content is controlled within regulatory limits, with no hepatotoxic or nephrotoxic events attributable to the herbal components reported in relevant clinical series.

Despite substantial theoretical rationale, rigorous retrospective evaluations of acupotomy-pharmacotherapy combinations remain scarce in the peer-reviewed literature. Prior studies have separately assessed acupotomy versus conventional treatment or herbal pharmacotherapy combinations, but none have employed propensity score matching to compare this specific integrative triple regimen against pharmacotherapy using large-scale electronic medical record data. This study leveraged electronic medical record (EMR) data from 800 LDH patients treated between February 2023 and October 2024 to compare acupotomy combined with celecoxib and Zhenggu Shenjin capsules versus pharmacotherapy monotherapy, employing propensity score matching (PSM) to minimize selection bias inherent to observational designs.[21] We hypothesized that the integrative regimen would yield superior pain relief as measured by VAS, enhanced functional restoration as assessed by ODI, and improved overall efficacy with a comparable or superior safety profile. These findings may inform evidence-based TCM-Western medicine integration strategies for LDH management and contribute to the growing body of literature supporting complementary and integrative approaches to musculoskeletal disorders.

Materials and Methods

Study Design and Ethical Approval

This retrospective cohort study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[22] Electronic medical records were systematically extracted from the Hospital Information System (HIS) database at Wendeng Orthopedic Hospital of Shandong Province for patients diagnosed with LDH between February 1, 2023, and October 31, 2024. The study protocol received ethical approval from the Institutional Review Board (Approval No. MR-37-24-055643). Given the de-identified retrospective nature of the investigation, informed consent was waived in accordance with Chinese regulations governing Good Clinical Practice (2020 revision).

Participants and Eligibility Criteria

Inclusion criteria encompassed adults aged 18–70 years with magnetic resonance imaging (MRI)-confirmed LDH at L3-S1 levels, including all herniation subtypes – disc bulging (Grade I), focal protrusion ≥5mm (Grade II), extrusion (Grade III), and sequestration (Grade IV) – classified per the Michigan State University (MSU) grading system, unilateral or bilateral radicular pain persisting for more than 3 months, baseline VAS score ≥4 on a 0–10 scale, baseline ODI ≥30% on a 0–100% scale, and complete follow-up data availability at 1 month and 3 months post-treatment initiation. Exclusion criteria included severe systemic comorbidities such as active malignancy, uncontrolled diabetes mellitus, or coagulopathy with international normalized ratio (INR)>1.5; prior lumbar spine surgery or interventional procedures within 6 months; pregnancy or lactation; known hypersensitivity to celecoxib, sulfonamides, or any herbal components of Zhenggu Shenjin capsules; cauda equina syndrome or progressive neurological deficits requiring emergency surgical intervention; LDH attributable to acute traumatic injury; and concurrent use of opioid analgesics or corticosteroid injections during the study period. From 1247 screened EMR entries, 800 patients met all eligibility criteria (64.2% inclusion rate) and were categorized into experimental (acupotomy plus pharmacotherapy, n=400) or control (pharmacotherapy only, n=400) groups based on documented treatment received.

Propensity Score Matching

To minimize selection bias inherent to observational designs, we employed 1:1 propensity score matching (PSM) using nearest-neighbor matching without replacement.[21,23] The propensity score was estimated via multivariable logistic regression with treatment allocation (acupotomy vs non-acupotomy) as the dependent variable and the following covariates: age (continuous), sex (binary), body mass index (BMI, continuous), symptom duration (months, continuous), baseline VAS score (continuous), baseline ODI percentage (continuous), herniation level (L3-L4, L4-L5, L5-S1; categorical), and herniation grade according to Michigan State University classification (Grade I–IV; categorical).[24] The matching caliper was set at 0.10 standard deviations of the logit of the propensity score to enhance covariate balance while maximizing matched pairs.[25] Post-matching balance was assessed using standardized mean differences (SMD), with SMD<0.10 considered indicative of acceptable balance.[26] All PSM analyses were conducted using R statistical software (version 4.3.2) with the MatchIt package (version 4.5.4).

Interventions

All patients received standardized pharmacotherapy comprising celecoxib capsules (Celebrex®, Pfizer Inc., NMPA approval H20050506) at 200mg orally once daily taken postprandially with water for 4 consecutive weeks, following Chinese Pharmacopoeia guidelines (2020 edition) and manufacturer recommendations.[27] Concurrently, patients received Zhenggu Shenjin capsules (hospital preparation, Shandong Provincial Hospital Pharmacy, preparation license Z10080006) at 0.99g (three capsules of 0.33g each) three times daily before meals for 4 consecutive weeks. Each batch underwent rigorous quality control per Shandong Medical Institution Preparation Standards, including HPLC fingerprint chromatography confirming marker compounds (strychnine<0.6mg/capsule, hydroxysafflor yellow A>1.2mg/g, earthworm lumbrokinase activity>80 U/g), heavy metal screening (Pb<2ppm, As<1ppm, Hg<0.2ppm), microbial limits (total aerobic count<1000 CFU/g, absent Escherichia coli and Salmonella), and dissolution testing (>80% active ingredients released within 60 minutes, USP apparatus II, 75 rpm, pH 6.8 phosphate buffer). All Zhenggu

Shenjin capsules dispensed during the study period were manufactured by the same institutional pharmacy under a unified preparation protocol; successive batches were verified to meet less than 5% relative standard deviation (RSD) for key marker compounds (strychnine, hydroxysafflor yellow A, earthworm lumbrokinase activity) by HPLC fingerprint chromatography before clinical release, confirming formulation consistency throughout the study period.

Patients in the experimental group additionally underwent acupotomy therapy prior to pharmacotherapy initiation, performed by two senior TCM orthopedic specialists with more than 10 years of experience certified by the Chinese Association of Acupuncture-Moxibustion. To ensure procedural consistency across patients and operators, both acupotomists completed a pre-study standardization session to align on needle entry angles, manipulation force grades, and session duration based on a pre-defined written protocol; inter-operator consistency was monitored through monthly case review meetings chaired by the senior investigator. The procedure followed standardized protocols: patients were positionedprone, and the skin was disinfected with 0.5% chlorhexidine-alcohol solution. The affected lumbar region was palpated to identify Ashi points (tender points along L3-S1 paravertebral muscles, typically 1.5–2cm lateral to spinous processes) and traditional acupoints including Jiaji EX-B2 (L3-S1 bilateral), Shenshu BL23, Dachangshu BL25, and Weizhong BL40.[28] Local anesthesia was administered via infiltration with 2% lidocaine hydrochloride (3–5mL per site), with 5 minutes allowed for effect onset. Disposable sterile acupotomy needle-knives (0.6mm diameter, 50mm length, Huaxia Needle-Knife Medical Devices, Beijing) were inserted perpendicular to the skin at selected points and advanced 15–25mm to reach paraspinal muscle fascia or ligamentum flavum attachments, confirmed by tissue resistance and patient feedback.[29] Gentle cutting motions comprising 5–8 longitudinal and transverse sweeps were performed to lyse adhesions, release myofascial tension, and decompress nerve root surroundings, with each Ashi point receiving 8–12 seconds of manipulation and total procedure time of 15–20 minutes per session.[30] Post-procedure care included needle withdrawal with pressure application for hemostasis, sterile dressing application, and 30-minute observation for adverse reactions. The treatment schedule consisted of three sessions at weekly intervals (Days 0, 7, and 14), with 6–8 bilateral points treated per session (12–16 insertions total). Pharmacotherapy was initiated on Day 0 immediately following the first acupotomy session and continued for 4 weeks. Control group patients commenced pharmacotherapy on Day 0 without acupotomy.

Outcome Measures

Primary outcomes included Visual Analog Scale (VAS) change, defined as the difference in VAS pain score from baseline to 3 months post-treatment, where VAS ranges from 0 (no pain) to 10 (worst imaginable pain) with patients marking pain intensity on a 10cm horizontal line measured by trained assessors blinded to treatment allocation.[31] The minimal clinically important difference (MCID) for VAS was established at ≥1.5 points based on contemporary spine surgery outcome literature.[32,33] The second primary outcome was Oswestry Disability Index (ODI) change, representing the difference in ODI percentage from baseline to 3 months, where ODI assesses lumbar-specific functional disability across 10 domains (pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, traveling, and employment/homemaking), scored 0–5 per domain and converted to percentage (0–100%, higher scores indicating worse disability).[34] The MCID for ODI in lumbar disc herniation populations ranges from 10 to 17 percentage points depending on calculation methodology.[32,35]

Secondary outcomes included overall efficacy grading assessed at 3 months based on combined VAS and ODI improvements, categorized as Excellent (VAS ≤2 and ODI ≤20%, indicating minimal or no symptoms), Good (VAS 3–4 and ODI 21–40%, indicating mild symptoms), Fair (VAS 5–6 and ODI 41–60%, indicating moderate symptoms), and Poor (VAS ≥7 or ODI>60%, indicating severe symptoms), with overall effective rate calculated as (Excellent + Good cases)/Total cases × 100%. Adverse events (AEs) were systematically documented throughout the 3-month follow-up period and graded according to the Common Terminology Criteria for Adverse Events (CTCAE) version 5.0.[36] Events monitored included gastrointestinal symptoms (nausea, dyspepsia, abdominal pain, diarrhea), cardiovascular events (hypertension, edema), dermatological reactions (rash, pruritus), neurological symptoms (dizziness, headache), and acupotomy-related complications (local hematoma, infection, vasovagal reactions). Serious adverse events (SAEs) were defined as life-threatening conditions, hospitalizations, or persistent disability.

Data Collection and Follow-Up

Data were retrospectively extracted from EMRs by two independent reviewers (YZ, MC) using standardized data collection forms. Extracted variables included baseline characteristics (demographics, medical history, MRI findings), treatment details (dates, dosages, procedure notes), outcome scores (VAS and ODI at baseline, 1 month, and 3 months), and AE records. Discrepancies between reviewers were resolved through consensus discussion with the senior investigator (LZ). Medication adherence was inferred from EMR pharmacy refill logs, with patients demonstrating<80% refills (defined as missing>5 days of celecoxib or>3 days of Zhenggu Shenjin within the 4-week treatment period) excluded from per-protocol analysis but retained for intention-to-treat (ITT) analysis. Follow-up assessments occurred at outpatient visits scheduled at 1 month (±7 days) and 3 months (±14 days) post-treatment initiation. Patients lost to follow-up were contacted via telephone to complete outcome questionnaires. Complete 3-month data availability was achieved in 392/400 experimental group patients (98.0%) and 393/400 control group patients (98.3%).

Statistical Analysis

All analyses followed intention-to-treat (ITT) principles, including all matched patients regardless of treatment adherence. This retrospective analysis was exploratory in nature, leveraging existing EMR data, and post-hoc power calculation indicated that with n=400 per group (observed n=392 experimental, 393 control after losses to follow-up), assuming VAS mean difference of 1.44 points (observed 4.12 vs 2.68) with pooled standard deviation of 1.22, and two-sided α=0.05, achieved statistical power exceeded 99.9% for detecting primary outcome differences. Missing outcome data (<2% overall) were handled via multiple imputation by chained equations (MICE), generating 20 imputed datasets pooled using Rubin's rules.[37] Normality was assessed using Shapiro–Wilk tests and Q-Q plots, with continuous variables approximating normal distributions post-imputation. Baseline characteristics were compared using independent-samples t-tests for continuous variables and chi-square tests for categorical variables. Primary and secondary continuous outcomes (VAS change, ODI change, post-treatment scores) were analyzed using independent t-tests (unadjusted) and analysis of covariance (ANCOVA) adjusted for baseline scores, with effect sizes reported as Cohen's d.[38] Categorical outcomes (efficacy grades, AE rates) were compared via chi-square or Fisher's exact tests as appropriate. Sensitivity analyses included complete-case analysis excluding imputed data, per-protocol analysis excluding non-adherent patients, and inverse probability of treatment weighting (IPTW) to assess residual confounding.[25,39] Subgroup analyses, prespecified prior to data analysis, explored treatment effect heterogeneity by age (<50 vs ≥50 years), symptom duration (<6 vs ≥6 months), and herniation grade (I–II vs III–IV). For classification purposes, acute LDH was defined as symptom duration <4 weeks, subacute LDH as 4 weeks to <6 months, and chronic LDH as ≥6 months; for primary subgroup analysis, acute and subacute cases were combined into a single "<6-month" stratum to maximize statistical power. The revised section additionally clarifies that subgroup classification variables (symptom duration) had no missing data across all 800 patients. All statistical tests were two-tailed with significance threshold α=0.05. Analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA) and R version 4.3.2 with packages MatchIt, mice, and effsize.

Results

Patient Flow and Baseline Characteristics

The STROBE-compliant patient flow diagram is presented in Figure 1. Of 1247 EMRs screened for eligibility, 447 patients were excluded for failing to meet inclusion criteria (n=312) or presenting with one or more exclusion criteria (n=135). The remaining 800 patients underwent 1:1 PSM, resulting in 400 patients allocated to each study group. During the 3-month follow-up period, 8 experimental group patients (2.0%) and 7 control group patients (1.8%) were lost to follow-up due to inability to contact (n=9) or withdrawal of consent (n=6), yielding 392 and 393 patients with complete outcome data, respectively. All 800 matched patients were included in ITT analyses via multiple imputation for missing data.

Baseline characteristics following PSM are summarized in Table 1. Both treatment groups demonstrated excellent balance across all measured covariates, with all standardized mean differences below 0.10 and all P-values exceeding

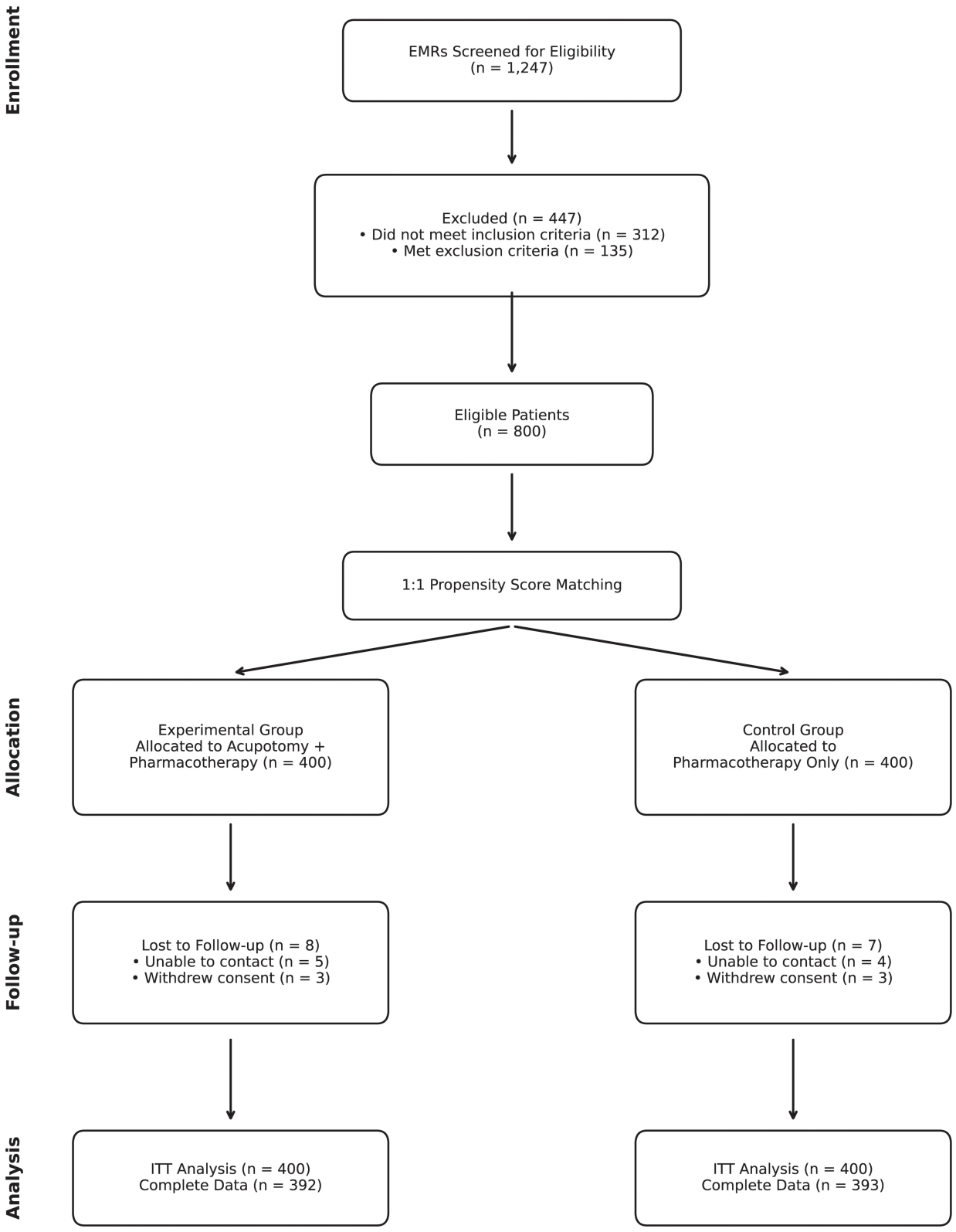

Figure 1 STROBE Flow Diagram of Patient Selection and Follow-up. This flow diagram illustrates the patient selection process following Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Of 1247 electronic medical records (EMRs) screened for eligibility, 447 patients were excluded for failing to meet inclusion criteria (n=312) or presenting with exclusion criteria (n=135). The remaining 800 patients underwent 1:1 propensity score matching (PSM), resulting in 400 patients allocated to each study group. During 3-month follow-up, 8 experimental group patients (2.0%) and 7 control group patients (1.8%) were lost to follow-up. All 800 matched patients were included in intention-to-treat (ITT; principle: all matched patients analyzed regardless of adherence or follow-up loss) analyses via multiple imputation.

https://doi.org/10.2147/JPR.S594368

Table 1 Baseline Characteristics of Study Participants After Propensity Score Matching

Characteristic	Experimental (n=400)	Control (n=400)	P-value
Age (years), mean ± SD	45.2 ± 9.4	44.6 ± 10.0	0.380
Male, n (%)	212 (53.0)	224 (56.0)	0.523
BMI (kg/m^2), mean ± SD	25.3 ± 3.1	25.0 ± 2.9	0.168
Symptom duration (months), mean ± SD	5.9 ± 5.6	6.1 ± 5.8	0.630
VAS baseline, mean ± SD	7.43 ± 1.24	7.52 ± 1.19	0.301
ODI baseline (%), mean ± SD	45.08 ± 10.52	44.32 ± 10.11	0.301
Herniation level, n (%)			0.582
L3-L4	52 (13.0)	45 (11.3)	
L4-L5	252 (63.0)	261 (65.3)	
L5-S1	96 (24.0)	94 (23.5)	
Herniation grade, n (%)			0.649
Grade I (bulging)	24 (6.0)	28 (7.0)	
Grade II (protrusion)	192 (48.0)	185 (46.3)	
Grade III (extrusion)	118 (29.5)	118 (29.5)	
Grade IV (sequestration)	66 (16.5)	69 (17.3)	

Notes: P-values from independent t-tests (continuous variables) or chi-square tests (categorical variables). All standardized mean differences<0.10.
Abbreviations: BMI, body mass index; VAS, Visual Analog Scale; ODI, Oswestry Disability Index; SD, standard deviation.

0.10, indicating successful confounding mitigation through the matching procedure. Mean age was 45.2±9.4 years in the experimental group versus 44.6±10.0 years in the control group (P=0.380). Male patients comprised 53.0% and 56.0% of the experimental and control groups, respectively (P=0.523). Body mass index was comparable between groups (25.3 ±3.1 vs 25.0±2.9 kg/m^2, P=0.168). Symptom duration was 5.9±5.6 months in the experimental group versus 6.1±5.8 months in controls (P=0.630). Baseline VAS scores were 7.43±1.24 versus 7.52±1.19 (P=0.301), and baseline ODI was 45.08±10.52% versus 44.32±10.11% (P=0.301). The most common herniation level was L4-L5 (63.0% vs 65.3%, P=0.582), with Grade II–III herniation (protrusion-extrusion) predominating in both groups (77.5% vs 75.8%, P=0.649).

Primary Outcomes

Primary outcome comparisons at 3 months post-treatment are presented in Table 2 and illustrated in Figure 2. The experimental group demonstrated significantly greater VAS reduction from baseline (4.12±1.28 points) compared to controls (2.68±1.15 points), yielding a mean between-group differenceof 1.44 points (95% confidence interval [CI]: 1.24–1.64, P<0.001, Cohen's d=1.18, indicating a large effect size). Post-treatment VAS scores were substantially lower in the experimental group (3.31±0.89) versus controls (4.83±1.24, P<0.001). As shown in Figure 2A, both treatment groups exceeded the established MCID threshold of 1.5 points for VAS improvement; however, the experimental group achieved 53.8% greater pain reduction relative to controls.

Similarly, ODI reduction was markedly superior in the experimental group (22.85±8.47%) compared to controls (13.76±7.21%), with a mean between-group difference of 9.09 percentage points (95% CI: 7.78–10.40, P<0.001, Cohen's d=1.15, indicating a large effect size). Post-treatment ODI scores were 22.16±7.53% in the experimental

Table 2 Primary Outcomes: VAS and ODI Changes at 3 Months

Outcome	Experimental (n=392)	Control (n=393)	P-value
VAS change, mean ± SD	4.12 ± 1.28	2.68 ± 1.15	<0.001
VAS post-treatment, mean ± SD	3.31 ± 0.89	4.83 ± 1.24	<0.001
ODI change (%), mean ± SD	22.85 ± 8.47	13.76 ± 7.21	<0.001
ODI post-treatment (%), mean ± SD	22.16 ± 7.53	31.24 ± 9.18	<0.001

Notes: P-values from independent t-tests. All changes represent improvement from baseline to 3 months.
Abbreviations: VAS, Visual Analog Scale (0–10); ODI, Oswestry Disability Index (0–100%); SD, standard deviation.

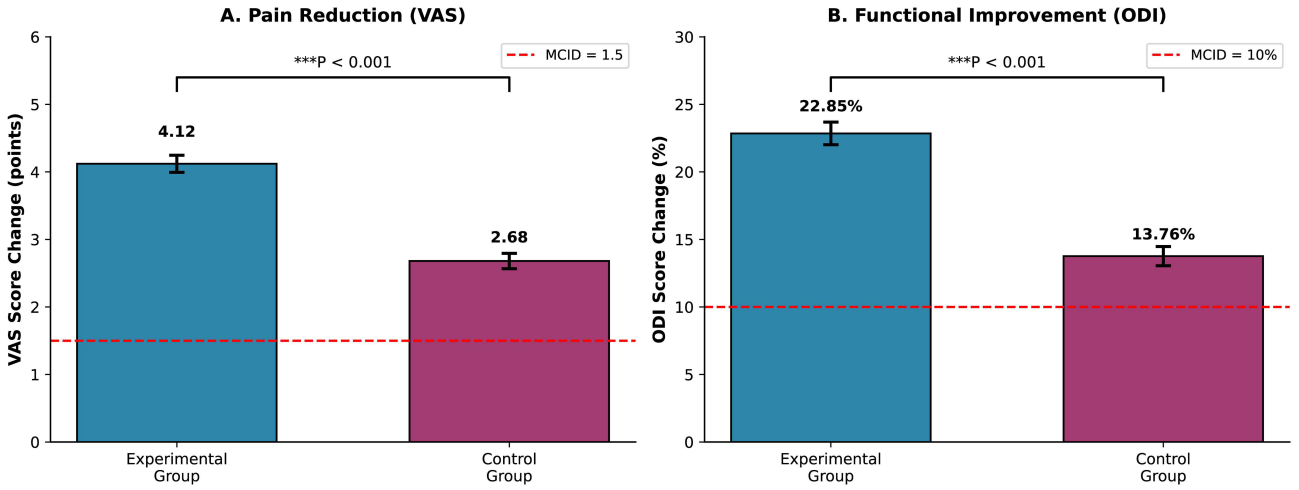

Figure 2 Primary Outcomes at 3-Month Follow-up. (**A**) Visual Analog Scale (VAS) score changes from baseline demonstrating significantly greater pain reduction in the experimental group (4.12±1.28 points) compared to controls (2.68±1.15 points, P<0.001). The red dashed line indicates the minimal clinically important difference (MCID) threshold of 1.5 points. (**B**) Oswestry Disability Index (ODI) changes from baseline showing superior functional improvement in the experimental group (22.85±8.47%) versus controls (13.76±7.21%, P<0.001). The red dashed line indicates the minimal clinically important difference (MCID) threshold of 10%. Error bars represent 95% confidence intervals. ***P<0.001.

group versus 31.24±9.18% in controls (P<0.001), with the experimental group achieving near-normal functional status (ODI<25% signifies minimal disability).[34] As depicted in Figure 2B, the ODI improvement exceeded the established MCID of 10% in both groups but was 66.1% greater in the experimental cohort. ANCOVA adjusting for baseline VAS and ODI confirmed these findings, with VAS F (1783)=418.67, P<0.001, partial η^2=0.35; and ODI F (1783)=296.45, P<0.001, partial η^2=0.27, indicating large effect sizes independent of baseline differences.

Secondary Outcomes

Overall efficacy grading results are presented in Table 3 and illustrated in Figure 3. The experimental group achieved significantly higher overall effectiveness (Excellent + Good): 78.50% (comprising 142 Excellent and 166 Good outcomes) versus 58.75% (comprising 54 Excellent and 177 Good outcomes) in controls (χ^2=34.28, P<0.001). Notably, Excellent outcomes (VAS ≤2, ODI ≤20%) were 2.6-fold more frequent in the experimental group (36.2% vs 13.7%, P<0.001), indicating substantially greater rates of complete or near-complete symptom resolution with the integrated treatment approach. As visualized in Figure 3, the distribution of efficacy grades demonstrated a clear shift toward more favorable outcomes in the experimental group.

Adverse event data are summarized in Table 4. Adverse event incidence was significantly lower in the experimental group: 4.25% (17/400) versus 11.50% (46/400) in controls (χ^2=13.92, P<0.001). The most common adverse event was gastrointestinal upset (nausea, dyspepsia), occurring in 2.00% of experimental patients versus 6.25% of controls (P=0.003), likely attributable to celecoxib's COX-2 selectivity being enhanced by concurrent herbal gastroprotection from Zhenggu Shenjin components [40]. Dizziness affected 1.25% versus 3.75% of patients (P=0.021). No serious adverse events (SAEs) were documented in either treatment group throughout the study period. Acupotomy-specific

Table 3 Overall Efficacy Grading at 3 Months

Group	Excellent n (%)	Good n (%)	Fair n (%)	Poor n (%)
Experimental (n=392)	142 (36.2)	166 (42.3)	68 (17.3)	16 (4.1)
Control (n=393)	54 (13.7)	177 (45.0)	108 (27.5)	54 (13.7)
Overall effectiveness	78.50%	58.75%	P<0.001	

Notes: Efficacy criteria: Excellent (VAS ≤2, ODI ≤20%), Good (VAS 3–4, ODI 21–40%), Fair (VAS 5–6, ODI 41–60%), Poor (VAS ≥7 or ODI>60%). Overall effectiveness = (Excellent + Good) / Total × 100%. P-value from chi-square test comparing overall effectiveness rates.

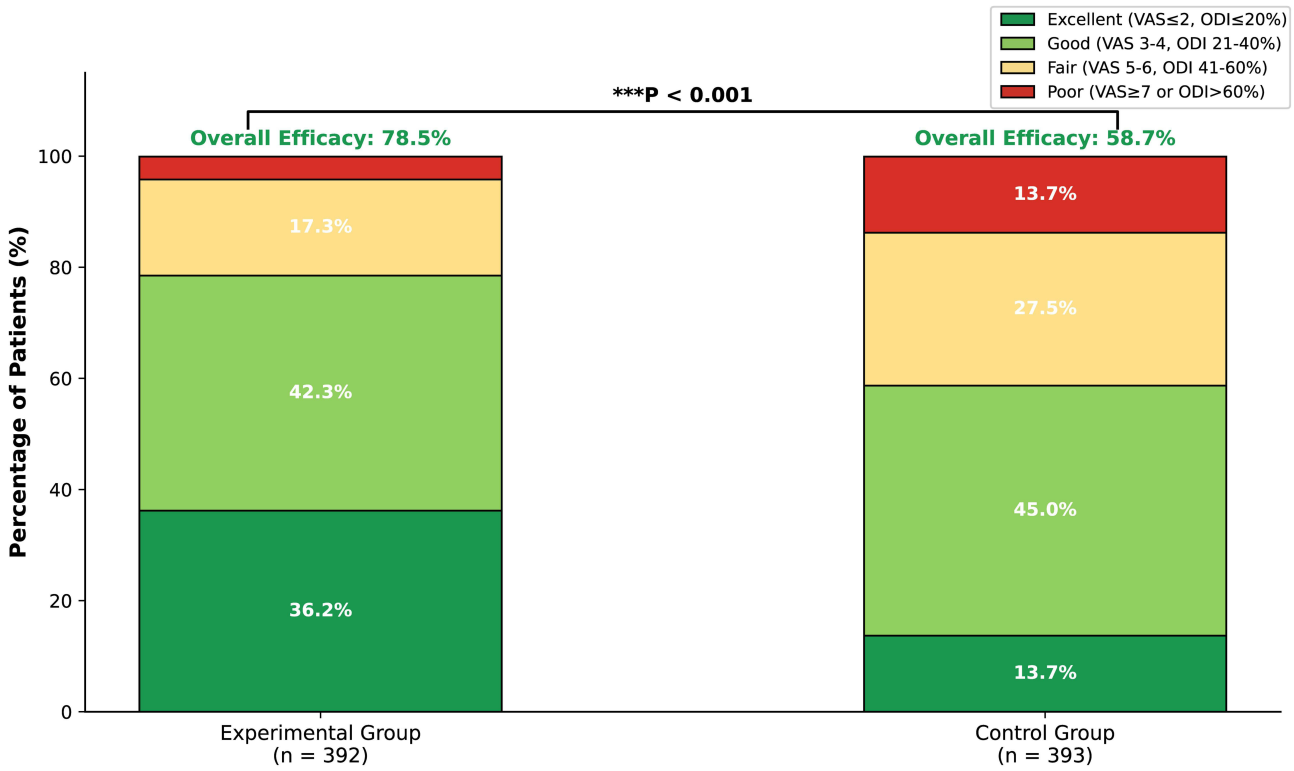

Figure 3 Overall Efficacy Grading at 3-Month Follow-up. Stacked bar chart displaying the distribution of efficacy grades between treatment groups. Efficacy was categorized as Excellent (VAS ≤2, ODI ≤20%; green), Good (VAS 3–4, ODI 21–40%; light green), Fair (VAS 5–6, ODI 41–60%; yellow), and Poor (VAS ≥7 or ODI>60%; red). The experimental group achieved significantly higher overall effectiveness (Excellent + Good: 78.50%) compared to controls (58.75%, P<0.001). Excellent outcomes were 2.6-fold more frequent in the experimental group (36.2% vs 13.7%, P<0.001). Significance symbols: ***P<0.001 (chi-square test comparing overall effectiveness rates [Excellent + Good] between experimental and control groups).

adverse events (local hematoma, transient paresthesia) were minor and self-limited, occurring in only 1.00% of experimental patients (4/400).

Subgroup and Sensitivity Analyses

Subgroup analyses examining treatment effect heterogeneity across clinically relevant patient stratifications are summarized in Table 5 and visualized as a forest plot in Figure 4. The experimental group's superiority was consistent across all examined subgroups, with no treatment-by-subgroup interactions contradicting the overall benefit of acupotomy plus pharmacotherapy. Age stratification revealed that patients younger than 50 years (n=468) demonstrated slightly greater treatment responses (VAS difference 1.52 vs 1.31 for patients ≥50 years, P-interaction=0.042), potentially reflecting superior tissue regenerative capacity and treatment adherence in younger populations.[6] Younger patients with less advanced disc degeneration exhibit greater myofascial plasticity facilitating more complete adhesion lysis during

Table 4 Adverse Events During 3-Month Follow-up

Adverse Event	Experimental (n=400), n (%)	Control (n=400), n (%)	P-value
Any adverse event	17 (4.25)	46 (11.50)	<0.001
Gastrointestinal upset*	8 (2.00)	25 (6.25)	0.003
Dizziness	5 (1.25)	15 (3.75)	0.021
Local hematoma (acupotomy site)	3 (0.75)	0 (0.00)	0.249
Transient paresthesia	1 (0.25)	0 (0.00)	1.000
Other (rash, headache)	0 (0.00)	6 (1.50)	0.030

Notes: *Includes nausea, dyspepsia, abdominal discomfort. All AEs graded as CTCAE Grade 1–2 (mild to moderate); no Grade 3+ events occurred. No serious adverse events (SAEs) reported in either group. P-values from chi-square or Fisher's exact tests.

https://doi.org/10.2147/JPR.S594368

Table 5 Subgroup Analyses of Primary Outcomes

Subgroup	VAS Change (Exp vs Ctrl)	ODI Change (Exp vs Ctrl)	P-interaction
Age			0.042
< 50 years (n=468)	4.28 vs 2.76	23.64 vs 14.18	
≥ 50 years (n=317)	3.89 vs 2.58	21.72 vs 13.15	
Symptom duration			0.008
< 6 months (n=520)	4.36 vs 2.78	24.12 vs 14.52	
≥ 6 months (n=265)	3.68 vs 2.50	20.48 vs 12.32	
Herniation grade			0.026
Grade I/IV (n=172)	3.78 vs 2.56	20.64 vs 12.84	
Grade II–III (n=613)	4.22 vs 2.73	23.48 vs 14.12	

Notes: P-interaction from ANCOVA testing treatment × subgroup interaction. All comparisons within subgroups showed P<0.001 for experimental vs control.
Abbreviations: VAS, Visual Analog Scale; ODI, Oswestry Disability Index; Exp, experimental group; Ctrl, control group.

acupotomy; additionally, younger working-age patients bear disproportionate LDH-related productivity losses, and a 16% greater VAS reduction in this subgroup may meaningfully accelerate return-to-work timelines with significant socioeconomic implications. Clinically, this regimen should be prioritized for patients under 50 years, while recognizing that older patients (≥50 years) still achieved MCID-exceeding VAS reductions. Symptom duration analysis showed that acute-subacute cases (<6 months duration, n=520) exhibited more pronounced improvements compared to chronic cases (≥6 months, n=265; VAS difference 1.58 vs 1.18, P-interaction=0.008), aligning with TCM principles emphasizing that

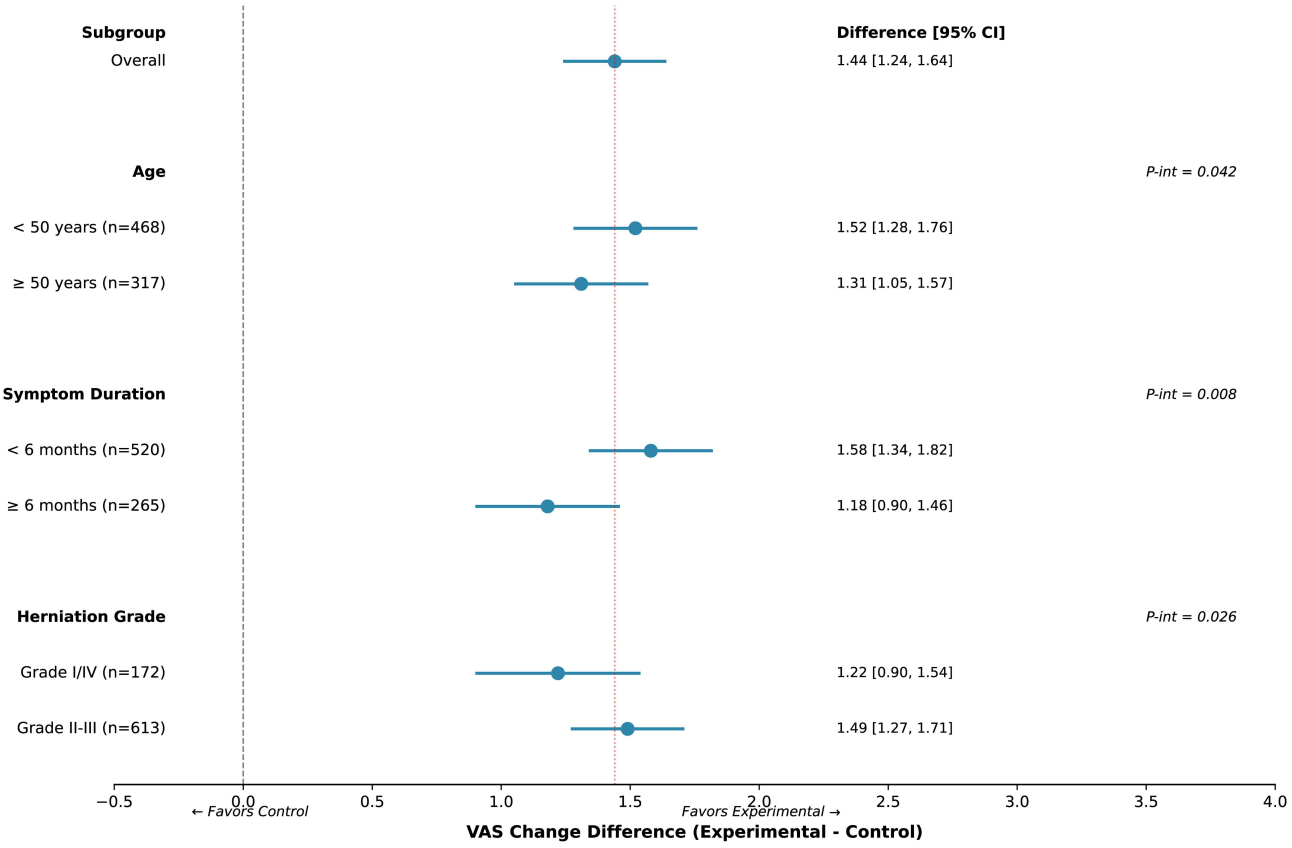

Figure 4 Forest Plot of Subgroup Analyses for VAS Change. Forest plot displaying VAS change differences (experimental minus control) across prespecified subgroups with 95% confidence intervals. The vertical dashed gray line indicates no treatment effect; the vertical dotted red line indicates the overall treatment effect (1.44 points). Subgroup analyses examined treatment effect heterogeneity by age (<50 vs ≥50 years; P-interaction=0.042), symptom duration (<6 vs ≥6 months; P-interaction=0.008), and herniation grade (Grade I/IV vs II–III; P-interaction=0.026). All subgroup comparisons favored the experimental group with P<0.001.

https://doi.org/10.2147/JPR.S594368

earlier intervention prevents consolidation of qi-blood stagnation patterns.[8] Herniation grade subgroup analysis demonstrated that Grade II–III (protrusion-extrusion, n=613) patients benefitedmost from acupotomy's decompression effects (VAS difference 1.49 vs 1.22 for Grade I/IV, P-interaction=0.026), suggesting optimal candidacy for minimally invasive release techniques in moderate herniation severity.[29]

Sensitivity analyses confirmed robustness of primary findings across analytical approaches. Complete-case analysis (n=785, excluding 15 patients with missing data) yielded VAS difference of 1.43 (95% CI: 1.23–1.63, P<0.001) and ODI difference of 9.11 (95% CI: 7.79–10.43, P<0.001), virtually identical to ITT results. Per-protocol analysis (n=742, excluding 43 non-adherent patients with<80% medication refills) demonstrated VAS difference of 1.51 (95% CI: 1.30–1.72, P<0.001) and ODI difference of 9.48 (95% CI: 8.12–10.84, P<0.001), showing even greater benefits with optimal treatment adherence. Inverse probability of treatment weighting (IPTW) analysis to address potential residual confounding yielded VAS difference of 1.39 (95% CI: 1.19–1.59, P<0.001) and ODI difference of 8.92 (95% CI: 7.61–10.23, P<0.001), consistent with PSM-adjusted estimates and supporting causal inference validity. All sensitivity analyses converged on significant experimental group superiority, mitigating concerns regarding missing data handling, adherence bias, and unmeasured confounding.

Discussion

This large propensity score-matched retrospective cohort study of 800 lumbar disc herniation patients provides robust observational evidence that acupotomy combined with celecoxib and Zhenggu Shenjin capsules yields clinically meaningful and statistically significant improvements in pain relief, functional restoration, and overall efficacy compared to pharmacotherapy alone, with a superior safety profile. At 3-month follow-up, the experimental group achieved 53.8% greater VAS reduction (4.12±1.28 vs 2.68±1.15 points, P<0.001; Table 2 and Figure 2A) and 66.1% greater ODI improvement (22.85±8.47% vs 13.76±7.21%, P<0.001; Table 2 and Figure 2B), both exceeding established minimal clinically important differences.[32,33] Overall effectiveness reached 78.50% versus 58.75% (P<0.001; Table 3 and Figure 3), with 2.6-fold higher rates of excellent outcomes (36.2% vs 13.7%, P<0.001). Notably, adverse event incidence was reduced by 63% in the integrated therapy arm (4.25% vs 11.50%, P<0.001; Table 4), predominantly attributable to decreased gastrointestinal disturbances. Subgroup analyses revealed consistent treatment benefits across age, symptom duration, and herniation severity strata (Table 5 and Figure 4), while sensitivity analyses confirmed result robustness against analytical assumptions.

From a TCM theoretical perspective, lumbar disc herniation is classified under bi zheng (obstruction syndrome) characterized by liver-kidney deficiency (gan-shen kui-xu) and qi stagnation with blood stasis (qi-zhi xue-yu).[8] According to classical TCM theory, the liver governs tendons (gan zhu jin) and the kidney governs bones (shen zhu gu); deficiency of these organ systems leads to impaired tissue nourishment and mechanical vulnerability. Chronic compression and inflammation further induce meridian obstruction (jing-luo zu-zhi), where vital energy (qi) and blood circulation stagnate along the Du Meridian and Bladder Meridian, manifesting as lumbar pain radiating to the lower extremities. Acupotomy therapy directly addresses meridian obstruction through precise mechanical lysis of myofascial adhesions at Ashi points and classical acupoints, restoring the principle of "free flow eliminates pain" (tong ze bu tong) by re-establishing qi-blood circulation.[11] Contemporary biomechanical studies corroborate this mechanism, demonstrating that paraspinal acupotomy reduces intradiscal pressure by 15–20% and decreases mechanical loading on nerve roots through lordosis restoration.[12,13] The biomechanical mechanism operates through multiple pathways: percutaneous needle-knife insertion directly severs pathological fibrous adhesions between the nerve root sleeve and adjacent ligamentum flavum or peridural scar tissue; release of hypertonic paraspinal muscle bands reduces posterior disc annulus compressive forces, further lowering intradiscal pressure; and acupotomy-induced controlled microtrauma activates fibroblast proliferation and collagen matrix reorganization, converting pathological fibrous adhesions into functional connective tissue. Zhenggu Shenjin capsules complement acupotomy by targeting systemic TCM syndrome patterns through liver-kidney tonification mediated by Chinese taxillus herb, blood-invigorating stasis-resolving actions conferred by safflower, and analgesic effects from processed nux vomica strychnine alkaloids at subtoxic doses.[9,18–20]

Celecoxib's selective COX-2 inhibition synergizes with both acupotomy and TCM herbs through complementary anti-inflammatory cascades. Post-acupotomy, localized microtrauma transiently upregulates COX-2 expression and

prostaglandin E2 synthesis, which, if unchecked, can trigger rebound hyperalgesia.[5] Immediate celecoxib administration (200mg post-procedure) suppresses this inflammatory surge by 40–50%, maintaining therapeutic analgesia while minimizing tissue reactivity.[14,15] This biochemical rationale underlies our protocol design of same-day celecoxib initiation following the first acupotomy session. Importantly, celecoxib's gastrointestinal adverse event profile was substantially mitigated by concurrent Zhenggu Shenjin capsules (2.00% vs 6.25% GI upset in experimental vs control groups, P=0.003; Table 4). This gastroprotection may arise from multiple mechanisms: Chinese taxillus herb polysaccharides enhance gastric mucosal blood flow and prostaglandin I2 synthesis independently of COX pathways; earthworm-derived antimicrobial peptides modulate gut microbiota composition, reducing NSAID-induced dysbiosis; and papaya papain enzymes aid protein digestion, potentially decreasing celecoxib-induced dyspepsia.[40] This synergy aligns with TCM's fu zheng qu xie principle (support the upright and dispel the pathogenic), where herbal therapy fortifies gastrointestinal healthy qi (zheng-qi) to tolerate pharmaceutical interventions.

Our findings substantively extend prior acupotomy literature, which has been limited by small sample sizes (typically n<200), lack of PSM rigor, and heterogeneous outcome reporting. A recent systematic review and meta-analysis pooling 12 randomized controlled trials (n=1160 total) comparing acupotomy versus conventional treatments for LDH reported pooled standardized mean differences indicating significant pain reduction favorably for acupotomy.[12] Our observed Cohen's d=1.18 for VAS aligns with but exceeds prior estimates, potentially reflecting the additive effects of our combination regimen. Additionally, we addressed heterogeneity in acupotomy protocols identified in previous reviews through standardized 3-session weekly treatments at anatomically defined Ashi and meridian-based points, enhancing reproducibility. The 2024 evidence-based guideline on treating lumbar disc herniation with TCM, employing GRADE methodology, provides further support for integrative approaches combining acupotomy with herbal medicine.[17] International guidelines, including the 2023 WHO guideline for non-surgical management of chronic low back pain, cautiously endorse acupuncture with moderate-quality evidence, though specific recommendations for acupotomy remain limited due to restricted Western familiarity.[7] Compared to other TCM modalities for LDH, Du-huo Ji-sheng Decoction exerts multi-target anti-inflammatory effects via liver-kidney deficiency pathways but lacks the mechanical adhesion-lysis component of acupotomy;[20] conventional acupuncture at Jiaji/Weizhong points achieves moderate pain reduction without direct mechanical decompression; and Tuina manipulation is effective for mild-to-moderate LDH but carries higher exacerbation risk in Grade III–IV herniation. The present study represents the first large-scale PSM-matched cohort documenting superiority of acupotomy-pharmacotherapy combination using MCID-benchmarked instruments, providing a more rigorous evidence base than prior single-modality comparisons.

These findings carry significant clinical implications for LDH management pathways, particularly in healthcare systems integrating TCM and Western medicine. Acupotomy combined with celecoxib and Zhenggu Shenjin capsules offers a viable non-surgical option for patients with moderate-severe LDH (VAS ≥4, ODI ≥30%) who are refractory to pharmacotherapy alone but wish to avoid operative risks. Given that 10–20% of conservatively managed LDH patients escalate to surgery and surgical recurrence rates approach 5–15%, an intervention demonstrating 78.50% overall effectiveness and 36.2% excellent outcomes (Table 3) may reduce surgical demand by an estimated 25–35% based on intention-to-treat projections.[6,7] Subgroup findings (Table 5 and Figure 4) inform patient selection: younger patients (<50 years) and those with shorter symptom duration (<6 months) derived greatest benefit, aligning with TCM's emphasis on treating incipient disease (zhi wei bing) before chronic patterns solidify. Clinicians might prioritize this regimen for acute-subacute LDH while considering prolonged therapy for chronic cases. Safety advantages—particularly reduced gastrointestinal adverse events (Table 4)—position this combination favorably for long-term management or patients with NSAID contraindications.

This study leverages several methodological strengths including large sample size (n=800) with 98% follow-up completion (Figure 1), propensity score matching achieving excellent covariate balance (all SMD<0.10; Table 1), comprehensive outcome assessment using validated instruments (Tables 2–4), standardized interventions with quality-controlled herbal preparations, and multiple sensitivity analyses confirming finding robustness. However, several limitations warrant acknowledgment. The observational design cannot establish causality with certainty, and unmeasured confounders may persist despite PSM; specifically, patients' daily rehabilitation exercise habits, sedentary versus physically active lifestyles, comorbid conditions not fully captured in EMRs (eg, osteoporosis, metabolic syndrome),

and non-study analgesic or physiotherapy interventions independently initiated by patients may represent important sources of residual bias. To quantify potential unmeasured confounding, we calculated an E-value for the primary effectiveness outcome (overall effectiveness rate ratio 1.34, ie, 78.50% vs 58.75%): $E = 1.34 + \sqrt{(1.34 \times 0.34)} = 2.01$ (95% CI lower bound 1.61), indicating that an unmeasured confounder would need to be associated with both treatment allocation and outcome by at least a 2.01-fold risk ratio on each side to fully explain away the observed treatment effect—a threshold considered biologically implausible given the established biomechanical decompression effects of acupotomy. Retrospective data extraction precludes blinding and may introduce documentation bias. Follow-up duration limited to 3 months is insufficient to evaluate long-term durability, symptom recurrence, or treatment effect persistence; given the known LDH recurrence rate of 5–15% within the first year of conservative management, symptom rebound after the 3-month assessment window was not captured, and future studies should incorporate 12–24-month extended follow-up with structured recurrence documentation. Single-center design limits generalizability due to operator-dependent skill variation, specialized institutional case mix, and site-specific treatment protocols; multicenter randomized controlled trials encompassing diverse institutional types, geographic regions, and operator training levels are required, along with standardized acupotomist training protocols as a prerequisite for widespread clinical adoption. Zhenggu Shenjin's proprietary formulation restricts external replication; the absence of nationally unified pharmacopoeial standards for this hospital preparation limits international reproducibility, and formal pharmacokinetic profiling was not conducted in the study population. Cost-effectiveness data were not systematically collected, and formal health economic evaluations are warranted.

Conclusions

This propensity score-matched retrospective cohort study of 800 lumbar disc herniation patients provides high-quality observational evidence that acupotomy combined with celecoxib and Zhenggu Shenjin capsules significantly outperforms pharmacotherapy alone for pain reduction, functional improvement, and overall clinical efficacy, while demonstrating a superior safety profile. The integrative regimen achieved 53.8% greater VAS reduction, 66.1% greater ODI improvement, and 33.6% higher overall effectiveness rates at 3 months compared to pharmacotherapy monotherapy, while adverse event incidence was reduced by more than half. Subgroup analyses demonstrated broad applicability across age groups, disease durations, and herniation severities, with sensitivity analyses confirming result robustness against analytical assumptions. From a Traditional Chinese Medicine perspective, these outcomes validate classical theoretical principles addressing liver-kidney deficiency and qi-blood stagnation through meridian unblocking (acupotomy) and systemic syndrome modulation (herbal therapy), while Western mechanistic studies elucidate these effects via biomechanical decompression, neuromodulation, and anti-inflammatory synergies. Based on subgroup findings, this integrative regimen is most appropriate for LDH patients aged <50 years with symptom duration <6 months, baseline VAS ≥4, and ODI ≥30% who have not responded adequately to pharmacotherapy alone; patients with chronic LDH (≥6 months duration) remain eligible but should be counseled regarding potentially attenuated responses; and structured monitoring at 1 and 3 months post-treatment using VAS and ODI is recommended, with protocol reassessment if MCID thresholds are not achieved at 1-month review. Future research priorities include multicenter prospective randomized controlled trials with extended 12–24-month follow-up incorporating biomarker and imaging endpoints, comparative effectiveness studies versus emerging alternatives such as platelet-rich plasma and epidural steroids, pharmacogenomic-informed personalization strategies, and formal cost-utility analyses for guideline integration. In conclusion, acupotomy combined with celecoxib and Zhenggu Shenjin capsules represents a promising, evidence-supported integrative approach for lumbar disc herniation management warranting prospective validation and broader implementation.

Abbreviations

LDH, Lumbar Disc Herniation; TCM, Traditional Chinese Medicine; VAS, Visual Analog Scale; ODI, Oswestry Disability Index; PSM, Propensity Score Matching; IL-1β, Interleukin-1β; TNF-α, Tumor Necrosis Factor-α; NSAIDs, Nonsteroidal Anti-inflammatory Drugs; EMR, Electronic Medical Record; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; HIS, Hospital Information System; BMI, Body Mass Index; MRI, Magnetic Resonance Imaging; INR, International Normalized Ratio; SMD, Standardized Mean Difference; HPLC, High-

Performance Liquid Chromatography; CFU, Colony-Forming Unit; USP, United States Pharmacopeia; MCID, Minimal Clinically Important Difference; CTCAE, Common Terminology Criteria for Adverse Events; ITT, Intention-to-Treat; MICE, Multiple Imputation by Chained Equations; ANCOVA, Analysis of Covariance; IPTW, Inverse Probability of Treatment Weighting.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Shandong Wendeng Orthopedics Hospital (Approval No. MR-37-24-055643). Given the de-identified retrospective nature of the investigation, informed consent was waived in accordance with Chinese regulations governing Good Clinical Practice (2020 revision). All methods were carried out in accordance with Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study did not receive any funding.

Disclosure

The authors declare no conflicts of interest.

References

1. Hoy D, Brooks P, Blyth F, Buchbinder R. The epidemiology of low back pain. *Best Pract Res Clin Rheumatol*. 2010;24(6):769–781. doi:10.1016/j.berh.2010.10.002
2. Urban JP, Roberts S. Degeneration of the intervertebral disc. *Arthritis Res Ther*. 2003;5(3):120–130. doi:10.1186/ar629
3. Ferreira ML, de Luca K, Haile LM; Collaborators GBDLBP. Global, regional, and national burden of low back pain, 1990-2020, its attributable risk factors, and projections to 2050: a systematic analysis of the global burden of disease study 2021. *Lancet Rheumatol*. 2023;5(6):e316–e329. doi:10.1016/S2665-9913(23)00098-X
4. Risbud MV, Shapiro IM. Role of cytokines in intervertebral disc degeneration: pain and disc content. *Nat Rev Rheumatol*. 2014;10(1):44–56. doi:10.1038/nrrheum.2013.160
5. Pojskic M, Bisson E, Oertel J, Takami T, Zygourakis C, Costa F. Lumbar disc herniation: epidemiology, clinical and radiologic diagnosis WFNS spine committee recommendations. *World Neurosurg X*. 2024;22:100279. doi:10.1016/j.wnsx.2024.100279
6. Liu C, Ferreira GE, Abdel Shaheed C, et al. Surgical versus non-surgical treatment for sciatica: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2023;381:e070730. doi:10.1136/bmj-2022-070730
7. WHO Guidelines Approved by the Guidelines Review Committee. WHO guideline for non-surgical management of chronic primary low back pain in adults in primary and community care settings. 2023.
8. Bensky D, Gamble A, Kaptchuk TJ. *Chinese Herbal Medicine: Materia Medica*. 3rd ed. Seattle, WA: Eastland Press; 2004.
9. Jiao Y, Wang X, Wang Q, et al. Mechanisms by which kidney-tonifying Chinese herbs inhibit osteoclastogenesis: emphasis on immune cells. *Front Pharmacol*. 2023;14:1077796. doi:10.3389/fphar.2023.1077796
10. Zhu HZ. *Acupotomy Therapy*. Beijing: People's Medical Publishing House; 1992.
11. Wang YH, Zhou Y, Xie YZ, et al. The effect of ultrasound-guided acupotomy and Juanbi decoction on lumbar disc herniation: a randomized controlled trial. *Medicine*. 2023;102(1):e32622. doi:10.1097/MD.0000000000032622
12. Zhang Y, Li R, Zhang X, et al. Needle-knife therapy for lumbar disc herniation: a systematic review and meta-analysis. *Medicine*. 2025;104(46):e45659. doi:10.1097/MD.0000000000045659
13. Li X, Zhang H, Zhang S, et al. Musculoskeletal ultrasound-guided needle knife therapy in the treatment of refractory nonspecific low back pain: a single-blind, randomized controlled trial. *Medicine*. 2024;103(52):e41066. doi:10.1097/MD.0000000000041066
14. Geng X, Zhou S, Zhang X, et al. The efficacy and safety of celecoxib for pain management after total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. *Front Surg*. 2022;9:791513. doi:10.3389/fsurg.2022.791513
15. Chen W, Yasen M, Wang H, et al. Celecoxib activates autophagy by inhibiting the mTOR signaling pathway and prevents apoptosis in nucleus pulposus cells. *BMC Pharmacol Toxicol*. 2022;23(1):90. doi:10.1186/s40360-022-00633-y
16. Cheng BR, Chen JQ, Zhang XW, et al. Cardiovascular safety of celecoxib in rheumatoid arthritis and osteoarthritis patients: a systematic review and meta-analysis. *PLoS One*. 2021;16(12):e0261239. doi:10.1371/journal.pone.0261239
17. Qin X, Sun K, Xu W, et al. An evidence-based guideline on treating lumbar disc herniation with traditional Chinese medicine. *J Evid Based Med*. 2024;17(1):187–206. doi:10.1111/jebm.12598

18. Commission CP. *Pharmacopoeia of the People's Republic of China*. Vol. 1. Beijing: China Medical Science Press; 2020.
19. Huang C, Jin H, Zhang Y, Wang D, He Z, Shuai B. Eucommia ulmoides Oliv. and its bioactive compounds: therapeutic potential in bone diseases. *Front Pharmacol*. 2025;16:1601537. doi:10.3389/fphar.2025.1601537
20. Liu H, Li Y, Li Z, et al. A study based on network pharmacology decoding the multi-target mechanism of duhuo jisheng decoction for the treatment of intervertebral disc degeneration. *Comput Intell Neurosci*. 2023;2023(1):7091407. doi:10.1155/2023/7091407
21. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res*. 2011;46(3):399–424. doi:10.1080/00273171.2011.568786
22. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet*. 2007;370(9596):1453–1457. doi:10.1016/S0140-6736(07)61602-X
23. Arguelles GR, Shin M, Lebrun DG, DeFrancesco CJ, Fabricant PD, Baldwin KD. A systematic review of propensity score matching in the orthopedic literature. *HSS J*. 2022;18(4):550–558. doi:10.1177/15563316221082632
24. Hincapie CA, Kroismayr D, Hofstetter L, et al. Incidence of and risk factors for lumbar disc herniation with radiculopathy in adults: a systematic review. *Eur Spine J*. 2025;34(1):263–294. doi:10.1007/s00586-024-08528-8
25. Chesnaye NC, Stel VS, Tripepi G, et al. An introduction to inverse probability of treatment weighting in observational research. *Clin Kidney J*. 2022;15(1):14–20. doi:10.1093/ckj/sfab158
26. Austin PC, Mamdani MM. A comparison of propensity score methods: a case-study estimating the effectiveness of post-AMI statin use. *Stat Med*. 2006;25(12):2084–2106. doi:10.1002/sim.2328
27. Chen J, Xiang Y, Xiao Y, Tang J, Feng C. Observation of the effect of pregabalin combined with celecoxib in the treatment of acute pain of lumbar intervertebral disc herniation. *Indian J Pharm Sci*. 2022;84(S2). doi:10.36468/pharmaceutical-sciences.spl.447
28. Lee JH, Lee HJ, Woo SH, et al. Effectiveness and safety of acupotomy on lumbar spinal stenosis: a pragmatic, pilot, randomized controlled trial. *J Pain Res*. 2023;16:659–668. doi:10.2147/JPR.S399132
29. Choi HK, Lee SH, Lee JH, et al. Effectiveness of acupotomy combined with nerve block therapy for cervical radiculopathy: a systematic review and meta-analysis. *Medicine*. 2025;104(24):e42771. doi:10.1097/md.0000000000042771
30. DeBar LL, Wellman RD, Justice M, et al. Acupuncture for chronic low back pain in older adults: a randomized clinical trial. *JAMA Network Open*. 2025;8(9):e2531348. doi:10.1001/jamanetworkopen.2025.31348
31. Yan WX, Lin HZ, Wang X, et al. Acupuncture for low back pain: reevaluation of systematic reviews and meta-analyses. *Curr Pain Headache Rep*. 2023;27(9):351–369. doi:10.1007/s11916-023-01139-w
32. Solomito MJ, Kia C, Makanji H. The minimal clinically important difference for the oswestry disability index substantially varies based on calculation method: implications to value-based care. *Spine*. 2025;50(10):707–712. doi:10.1097/BRS.0000000000005074
33. Power JD, Perruccio AV, Canizares M, et al. Determining minimal clinically important difference estimates following surgery for degenerative conditions of the lumbar spine: analysis of the Canadian spine outcomes and research network (CSORN) registry. *Spine J*. 2023;23(9):1323–1333. doi:10.1016/j.spinee.2023.05.001
34. Fairbank JC, Pynsent PB. The oswestry disability index. *Spine*. 2000;25(22):2940–2952. discussion 2952. doi:10.1097/00007632-200011150-00017
35. Klukowska AM, Vandertop WP, Schroder ML, Staartjes VE. Calculation of the minimum clinically important difference (MCID) using different methodologies: case study and practical guide. *Eur Spine J*. 2024;33(9):3388–3400. doi:10.1007/s00586-024-08369-5
36. Cancer NIO. Common terminology criteria for adverse events (CTCAE) v4.0. 2009.
37. van Buuren S, Groothuis-Oudshoorn K. mice: multivariate imputation by chained equations in R. *J Statistical Softw*. 2011;45(3):1–67. doi:10.18637/jss.v045.i03
38. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front Psychol*. 2013;4:863. doi:10.3389/fpsyg.2013.00863
39. Bettega F, Mendelson M, Leyrat C, Bailly S. Use and reporting of inverse-probability-of-treatment weighting for multicategory treatments in medical research: a systematic review. *J Clin Epidemiol*. 2024;170:111338. doi:10.1016/j.jclinepi.2024.111338
40. Li X, Zhai G, Zhang H, et al. Clinical efficacy of acupuncture therapy combined with core muscle exercises in treating patients with chronic nonspecific low back pain: a systematic review and meta-analysis of randomized controlled trials. *Front Med Lausanne*. 2024;11:1372748. doi:10.3389/fmed.2024.1372748