

Effectiveness of Acupotomy Combined with Topical Diclofenac for Knee Osteoarthritis: A Randomized Controlled Trial

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Purpose: We sought to determine whether acupotomy, when combined with topical diclofenac diethylamine emulgel, could (a) reduce pain, and (b) improve functional outcomes in patients with knee osteoarthritis, compared with topical diclofenac alone.

Methods: This assessor-blinded, single-center randomized clinical trial was conducted at Beijing Hospital of Traditional Chinese Medicine, Capital Medical University. Participants aged 40 to 80 with knee osteoarthritis and a pain score of 4 or higher were randomly assigned, via a computer-generated sequence, to an acupotomy intervention group or a control group. Both groups used diclofenac diethylamine emulgel four times daily for 4 weeks, with acupotomy group receiving four acupotomy sessions. Primary outcome was proportion achieving minimal clinically important pain and function improvements. Analyses followed an intention-to-treat approach, with significance at a two-sided P -value < 0.05 . Because of the nature of acupotomy, participants and practitioners could not be blinded.

Results: Response rates at 4 weeks were 92.55% (93 of 100) in acupotomy group and 61.54% (61 of 99) in control group. Rate differences were 31.01% (95% CI, 19.70% to 42.33%; $P < 0.001$). Benefit persisted at week 24 (90.32% vs 38.46%; rate difference, 51.86%; 95% CI, 40.20% to 63.52%; $P < 0.001$). Secondary outcomes showed greater improvement in NRS and WOMAC scores in acupotomy group at all time points ($P < 0.001$).

Conclusion: Acupotomy combined with topical diclofenac effectively reduces pain and improves function in knee osteoarthritis patients. Acupotomy can be considered an adjunctive therapy. This single-center, assessor-blinded trial was limited by the inability to blind participants and practitioners due to the nature of the intervention.

Keywords: acupotomy, knee, osteoarthritis, randomized controlled trial

Introduction

Knee osteoarthritis (OA) is a prevalent joint disorder characterized by chronic pain and functional disability.^{1,2} Beyond its clinical manifestations, knee OA is now recognized as a complex whole-joint disease, involving coordinated pathological changes across multiple articular structures—including progressive degeneration of hyaline cartilage and the menisci, synovial inflammation and fibrosis, biomechanical and inflammatory alterations of the infrapatellar fat pad, and maladaptive remodeling of the subchondral bone.^{3–6} Knee OA remains the largest component of the global OA burden, exhibiting a 2020 age-standardized prevalence of 4307.4 cases per 100,000 population.^{7,8} Driven by population aging and rising comorbidity profiles, its nonfatal disease burden has increased substantially and is projected to grow

markedly by 2050. Knee OA is more common among women, the obese, and individuals with a history of knee injuries.⁹ Key risk factors include advancing age, repetitive joint use, knee misalignment, and muscle weakness.¹⁰

No existing treatment can completely prevent the progression of knee OA. Available treatment methods include non-pharmacological approaches like exercise and patient education, pharmacological options such as non-steroidal anti-inflammatory drugs (NSAIDs) and intra-articular corticosteroids, and surgical interventions like knee replacement.^{11,12} However, exercise therapy faces challenges in implementation and adherence, while patient education alone offers limited benefits.^{2,13} Long-term use of NSAIDs may bring about gastrointestinal irritation, ulcers and bleeding, and intra-articular steroid injections may have deleterious effects on cartilage.^{14–16} Knee replacement surgery, though beneficial for severe cases, can result in serious adverse events, lengthy recovery, and minimal effects on quality-adjusted life years.^{17,18} Due to these limitations, more patients are eagerly seeking complementary therapies that can satisfy the need for pain relief and improved function.

Acupotomy is a minimally invasive technique that integrates principles of acupuncture and micro-invasive soft-tissue release.^{19,20} It is proposed to act by mechanically releasing periarticular adhesions and contractures, reducing aberrant mechanical stress, and modulating local inflammatory and nociceptive processes.^{21–23} Given the substantial symptom burden of knee OA and the limitations of existing non-surgical treatments, interest in acupotomy has grown. Although recent reviews and meta-analyses suggest potential benefit, most prior studies are constrained by small samples and methodological weaknesses.^{24–27} Robust randomized evidence is therefore needed. This trial aims to evaluate whether acupotomy, as an adjunctive therapy to topical diclofenac diethylamine emulgel, can relieve pain and improve function in knee OA patients compared to topical diclofenac diethylamine emulgel alone.

Methods

Study Design

This single-center, parallel-group, assessor-blinded RCT was conducted at the Beijing Hospital of Traditional Chinese Medicine affiliated with Capital Medical University. Ethical approval was obtained from the hospital's Medical Ethical Review Committee (No. 2020BL02-057-02), and the study was registered with the Chinese Clinical Trial Registry (ChiCTR2100043005). The detailed protocol adhered to the Declaration of Helsinki, and was previously published ([Supplement 1](#)).²⁸ All patients provided written informed consent before enrollment. The study follows the Consolidated Standards of Reporting Trials (CONSORT) guidelines.²⁹

Participants

Recruitment involved screening outpatients from the hospital. Additionally, recruitment advertisements were displayed in the outpatient hall and on the We-Media platform.

Eligible patients were men and women aged 40 to 80 years, diagnosed with knee OA based on the American College of Rheumatology (ACR) criteria.³⁰ They experienced symptoms for more than 6 months and had radiologic evidence of Kellgren-Lawrence grade II to IV within the last 6 months.³¹ Eligibility required a pain severity score of 4 or higher on a 10-point numerical rating scale (NRS) (range, 0–10, with higher scores indicating greater pain).³² Only those who provided signed written informed consent were enrolled.

The key exclusion criteria included recent or planned knee interventions (including surgery, arthroscopy, intra-articular injection within the past 6 months, or acupotomy/acupuncture within the past 3 months); current use of analgesics, anti-inflammatory drugs, or other medications that may interfere with pain assessment (during the trial, participants were required to avoid all pain-related medications except the prescribed topical diclofenac and rescue medication); knee pain caused by other conditions; severe acute or chronic diseases (such as advanced heart failure, uncontrolled hypertension, recent stroke, severe kidney or liver dysfunction, active malignancy, or poorly controlled diabetes [HbA1c > 9%]); or a pronounced fear of acupotomy. Participants could continue their stable doses of medications for chronic conditions (eg, antihypertensives, hypoglycemics) throughout the trial period. Details are in [eTable 1](#) of [Supplement 2](#).

Randomization and Blinding

Eligible patients were randomly assigned to either acupotomy group or control group in a 1:1 ratio using block randomization, managed by an independent statistician. Each block consisted of 4 slots to ensure even distribution. The randomization sequence was sealed in opaque, sequentially numbered envelopes, accessed only by the researcher responsible for participant enrollment. Due to the nature of acupotomy, blinding of patients and practitioners was not possible. However, outcome assessors and statisticians were blinded to group assignments. Data analysis was independently conducted by the blinded statistician. The study procedure is detailed in [Figure 1](#).

Interventions

Patients in both groups applied topical diclofenac diethylamine emulgel (Voltalin, Beijing Novartis Pharma Ltd) 4 times daily for 4 weeks, with dosage adjusted to the pain area.³³ Patients documented their usage of diclofenac diethylamine emulgel daily.

Patients in the acupotomy group received additional weekly acupotomy treatments at five fixed acupoints and two Ah Shi points (tender points identified by a patient's pain response upon palpation, allowing for targeted pain relief). The fixed acupoints included Dubi (ST35), Neixiyan (EX-LE4), Shiqizhui (EX-B8), Yaoyangguan (GV3), and Xiyangguan (GB33), while Ah Shi points were individually determined based on each patient's specific pain locations during physical examination. These acupoints represent a standardized clinical regimen at our center and were selected for their relevance to periarticular soft-tissue tension, pain-generating structures, and biomechanical imbalance in knee OA.

The acupotomy procedure included: (a) Localization and Preparation: With the patient in a supine position, the aforementioned acupoints were identified and marked according to the descriptions provided in [Supplement 3](#). The skin at these sites was disinfected, and sterile drapes were applied. (b) Orientation and Pressure Separation: The acupotomy blade was oriented parallel to the skin and key anatomical structures. Slight pressure was applied to separate superficial tissues, nerves, and vessels. (c) Incision and Treatment: The blade was advanced until the tip reached the bone surface. Then, the needle was penetrated into the periosteum and manipulated to release tension and dissolve adhesions. For Ah Shi points, the needle was manipulated in multiple directions to achieve an adequate release. (d) Post-procedure Care: After the treatment, the needle was removed, and pressure was applied to control bleeding. The treated area was covered with a sterile dressing to prevent infection. A photograph of the acupotomy instrument and a schematic of the procedure are provided in [Supplement 4](#).

Loxoprofen sodium tablets (Loxonin, Dachi Sankyo Pharma Ltd) were provided as rescue medication, with usage documented by outcome assessors.³⁴ During the trial, participants were required to avoid all pain-related medications except the prescribed study and rescue medications. They could continue routine medications for chronic conditions, like antihypertensives or hypoglycemics, as long as dosages stayed stable, ensuring consistency in chronic condition management and trial integrity.

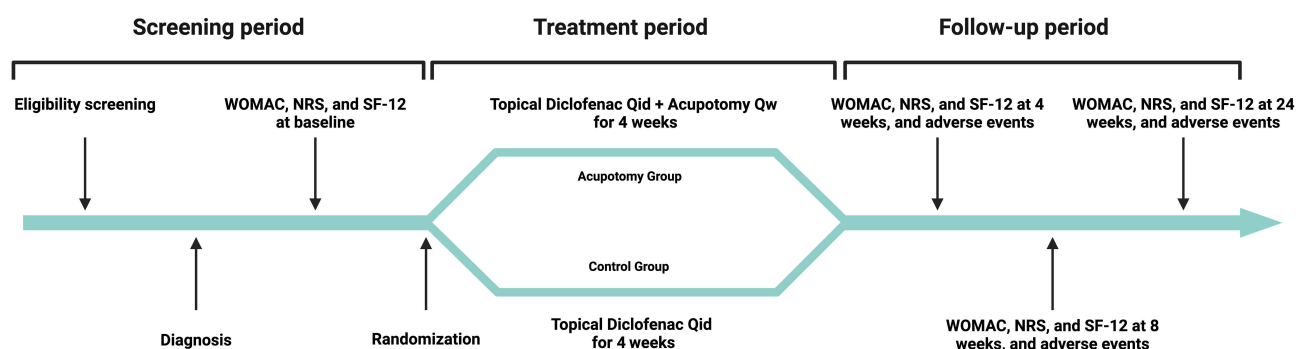


Figure 1 Study Procedures.

Abbreviations: WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; NRS, Numerical Rating Scale; SF-12, 12-item Short Form Health Survey; Qid, four times a day; Qw, once a week.

Outcomes

The primary outcome was the response rate at week 4, defined as the proportion of patients who achieved minimal clinically important improvement (MCII) on both the NRS and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) function subscale.^{32,35,36} MCII was operationalized as a reduction of ≥ 2 points on the 10-point NRS and ≥ 6 points on the 68-point WOMAC function subscale.

Secondary outcomes, assessed at weeks 4, 8, and 24, included changes in knee pain, physical function, stiffness, quality of life, and rescue medication use. Pain levels were measured using both the NRS (range 0–10) and the WOMAC pain subscale (range 0–20). Physical function and stiffness were evaluated using the WOMAC function (range 0–68) and stiffness (range 0–8) subscales, respectively. Quality of life was assessed with the 12-item Short Form (SF-12) health survey (range 0–100).³⁷ Rescue medication use was documented throughout the study to assess additional pain management needs. Due to the increase in patient volumes and reallocation of medical resources during the COVID-19 pandemic, the planned biomarker analyses, including tumor necrosis factor- α , interleukin-1 β , and matrix metalloproteinase-3, were omitted to prioritize essential healthcare services and ensure patient safety.

Adverse events were recorded, including the occurrence time, severity, management, and prognosis, to assess treatment safety and tolerability.

Statistical Analysis

The sample size was 80 patients each group calculated by PASS 11.0.7 (NCSS, LLC, USA) software with an aim for a response rate of 60% in the control group and 80% in the acupotomy group, ensuring 80% power at a 5% significance level. Accounting for a 20% dropout rate, 100 patients per group were required (a total of 200 patients).

There were 3 analysis populations: Intention-To-Treat (ITT) set, Per-Protocol (PP) set, and Safety Set (SS) set, with detailed definitions provided in [eTable 2](#) of [Supplement 2](#). Baseline characteristics were summarized using the ITT population. For normally distributed variables, means $\pm$ standard deviation (SD) was calculated. For non-normally distributed variables, medians with interquartile ranges (IQR) were used.

The primary analysis was based on the ITT principle. Comparisons of response rates were analyzed using the χ^2 -test for proportions without imputation for missing data. Sensitivity analyses were conducted for response rates, including additional calculations using the Last Observation Carried Forward (LOCF) method in ITT. Further sensitivity analyses were conducted in the PP set, comparing response rates using the χ^2 -test. Logistic regression analyses, adjusted for baseline characteristics and rescue medication usage, were performed across both sets, applying three approaches to handle missing data: no imputation, LOCF, and multiple imputation.

Secondary outcomes, including changes from baseline in pain, physical function, stiffness, and quality of life, were compared between groups using independent samples *t*-tests. Rescue medication usage was assessed using Fisher's exact test. Safety was analyzed in the SS population, with differences in adverse events assessed using Fisher's exact test.

All statistical tests were two-sided, with a significance level set at $P < 0.05$. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA).

Results

From March 1st, 2021, and June 30th, 2023, 285 patients with knee OA were screened, of whom 200 patients were randomized ([Figure 2](#)). A single participant was mistakenly registered in the randomization system twice. The duplicate record, which contained no clinical data, was eliminated prior to analysis in accordance with CONSORT recommendations. In the acupotomy group, 93 patients completed all scheduled treatments and final follow-up assessments. Five patients dropped out due to adverse events and 2 due to loss to follow-up. In the control group, 91 patients completed the study, with 8 patients dropping out: 1 during week 2 and 7 during week 4, all due to loss to follow-up. The detailed baseline demographics are presented in [Table 1](#).

For the primary outcome in the ITT population without imputation, the response rate at week 4 in the acupotomy group was higher than that in the control group (92.55% vs 61.54%; difference, 31.01%; 95% CI, 19.70%–42.33%; $P < 0.001$). The benefit persisted at subsequent time points, with rates at week 8 (91.49% vs 59.34%; difference, 32.15%;

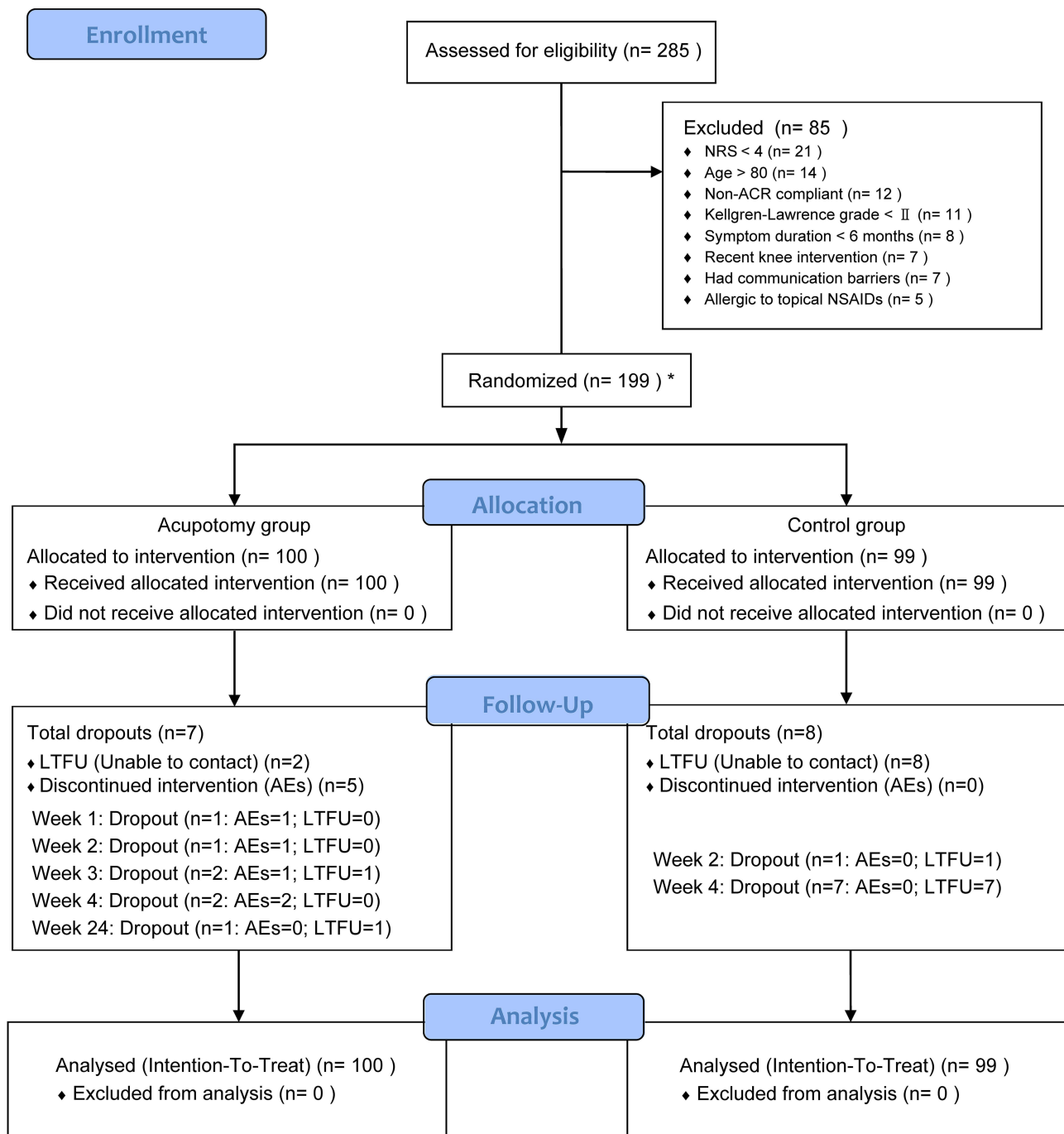


Figure 2 The Patient Enrollment Flowchart. * One duplicate participant was removed, resulting in 199 patients being.

Abbreviations: NRS, Numerical Rating Scale; ACR, American College of Rheumatology; NSAIDs, Nonsteroidal Anti-Inflammatory Drugs; AEs, Adverse Events; LTFU, Loss to Follow-Up.

95% CI, 20.59%-43.71%; $P < 0.001$) and week 24 (90.32% vs 38.46%; difference, 51.86%; 95% CI, 40.20%-63.52%; $P < 0.001$) (Table 2 and Figure 3). The robustness of our findings was supported by sensitivity analyses using different imputation methods, adjusted logistic regression, and per-protocol analysis (eTables 3 and 4 of Supplement 2). Subgroup analyses by age, BMI, and sex showed consistent treatment effects across subgroups, with no significant interactions (eTables 5 and 6 of Supplement 2).

Table 1 Participant Demographic and Baseline Characteristics

Characteristic	Acupotomy Group (N=100)	Control Group (N=99)
Age, mean $\pm$ SD, years	61.79 $\pm$ 8.37	60.99 $\pm$ 8.87
Gender, No. (%)		
Female	10(10.00)	15(15.15)
Male	90(90.00)	84(84.85)
Ethnicity, No. (%)		
Han	96(96.00)	95(95.95)
Minorities	4(4.00)	4(4.04)
Weight, mean $\pm$ SD, kg	66.66 $\pm$ 11.56	69.05 $\pm$ 10.57
Height, mean $\pm$ SD, cm	162.55 $\pm$ 6.01	162.23 $\pm$ 6.84
BMI, mean $\pm$ SD, kg/m ²	25.18 $\pm$ 3.85	26.21 $\pm$ 3.38
Affected knee joint, No. (%)		
Left	44(44.00)	51(51.52)
Right	56(56.00)	48(48.48)
NRS, mean $\pm$ SD	7.13 $\pm$ 1.23	6.92 $\pm$ 1.31
WOMAC, mean $\pm$ SD		
Pain subscale	7.49 $\pm$ 2.97	7.44 $\pm$ 2.66
Stiffness subscale	2.50 $\pm$ 1.69	2.40 $\pm$ 1.73
Function subscale	27.25 $\pm$ 9.17	27.41 $\pm$ 8.68
SF-12, mean $\pm$ SD		
Physical health	34.82 $\pm$ 6.70	35.12 $\pm$ 7.83
Mental health	47.05 $\pm$ 10.56	48.19 $\pm$ 10.59
Past treatment, No. (%)		
Medications	57(57.00)	52(52.53)
Injections	12(12.00)	17(17.17)
Acupotomy	1(1.00)	1(1.01)
Acupuncture	22(22.00)	28(28.28)
Physical therapy	4(4.00)	8(8.08)

Abbreviations: SD, standard deviation; BMI, body mass index; NRS, Numerical Rating Scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; SF-12, 12-item Short Form Health Survey.

Table 2 Primary and Secondary Outcomes of This Study Without Imputation

Outcomes	Acupotomy Group (N=100)	Control Group (N=99)	Difference (95% CI)	P value
Response rates, No. (%)				
Week 4	87 (92.55)	56 (61.54)	31.01 (19.70, 42.33)	<0.001
Week 8	86 (91.49)	54 (59.34)	32.15 (20.59, 43.71)	<0.001
Week 24	84 (90.32)	35 (38.46)	51.86 (40.20, 63.52)	<0.001
NRS score, mean $\pm$ SD				
Week 4	2.21 $\pm$ 1.64	4.41 $\pm$ 2.09	-2.20 (-2.73 to -1.67)	<0.001
Week 8	2.49 $\pm$ 1.56	4.65 $\pm$ 1.91	-2.16 (-2.65 to -1.67)	<0.001
Week 24	3.03 $\pm$ 1.43	5.07 $\pm$ 1.80	-2.04 (-2.49 to -1.59)	<0.001
WOMAC Pain score, mean $\pm$ SD				
Week 4	2.88 $\pm$ 2.15	4.81 $\pm$ 3.01	-1.93 (-2.66 to -1.20)	<0.001
Week 8	3.03 $\pm$ 2.01	4.90 $\pm$ 2.84	-1.87 (-2.56 to -1.18)	<0.001
Week 24	3.29 $\pm$ 1.86	5.27 $\pm$ 2.77	-1.98 (-2.64 to -1.32)	<0.001
WOMAC Stiffness score, mean $\pm$ SD				
Week 4	1.37 $\pm$ 1.06	1.89 $\pm$ 1.44	-0.52 (-0.87 to -0.17)	0.006
Week 8	1.37 $\pm$ 1.05	2.02 $\pm$ 1.39	-0.65 (-0.99 to -0.31)	<0.001
Week 24	1.48 $\pm$ 0.97	2.11 $\pm$ 1.37	-0.63 (-0.96 to -0.30)	0.001

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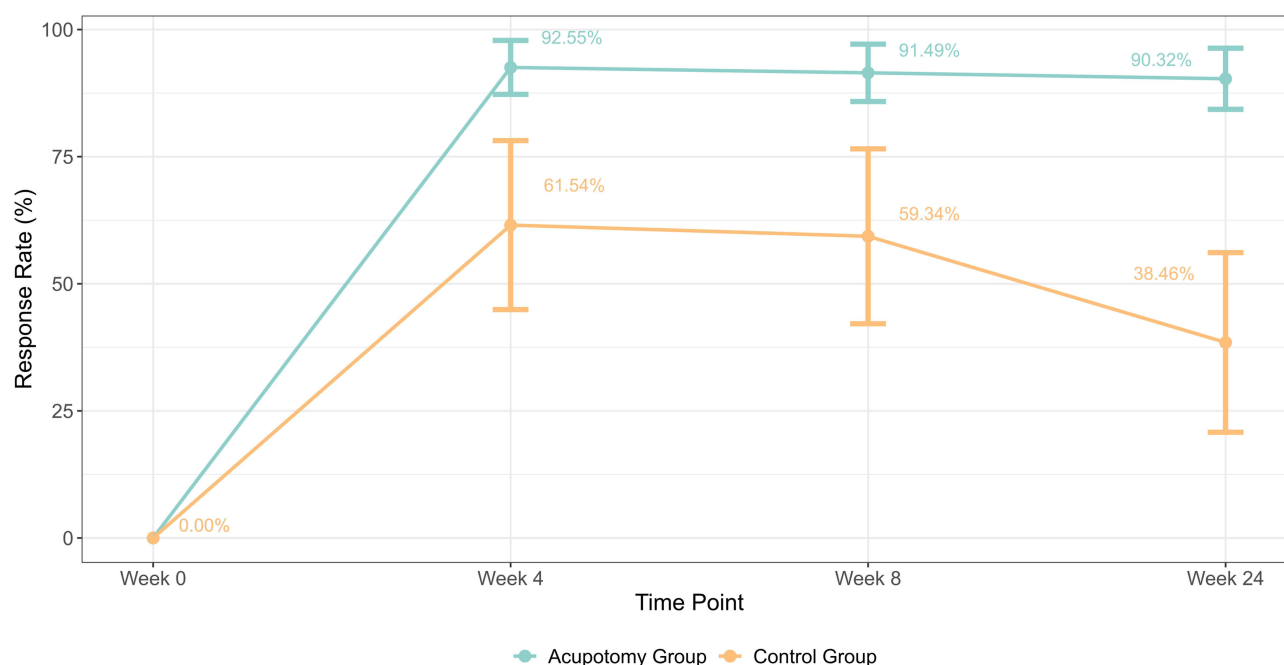
Table 2 (Continued).

Outcomes	Acupotomy Group (N=100)	Control Group (N=99)	Difference (95% CI)	P value
WOMAC Function score, mean $\pm$ SD				
Week 4	11.13 $\pm$ 7.70	18.10 $\pm$ 9.73	-6.97 (-9.42 to -4.52)	<0.001
Week 8	11.38 $\pm$ 6.66	18.19 $\pm$ 9.19	-6.81 (-9.06 to -4.56)	<0.001
Week 24	12.45 $\pm$ 6.55	19.79 $\pm$ 9.24	-7.34 (-9.58 to -5.10)	<0.001
SF-12 physical health, mean $\pm$ SD				
Week 4	43.57 $\pm$ 7.06	37.14 $\pm$ 6.26	6.44(4.50, 8.38)	<0.001
Week 8	42.65 $\pm$ 6.91	36.61 $\pm$ 5.87	6.05(4.18, 7.91)	<0.001
Week 24	41.78 $\pm$ 6.59	35.72 $\pm$ 5.47	6.06(4.29, 7.83)	<0.001
SF-12 mental health, mean $\pm$ SD				
Week 4	56.88 $\pm$ 6.80	52.36 $\pm$ 8.79	4.52(2.24, 6.79)	<0.001
Week 8	57.50 $\pm$ 6.64	52.42 $\pm$ 8.41	5.08(2.89, 7.28)	<0.001
Week 24	57.44 $\pm$ 6.34	50.86 $\pm$ 8.91	6.57(4.32, 8.82)	<0.001

Abbreviations: CI, confidence interval; SD, standard deviation; NRS, Numerical Rating Scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; SF-12, 12-item Short Form Health Survey.

Consistent improvements were observed in the acupotomy group across secondary outcomes. At week 4, the NRS scores indicated a substantial reduction in the acupotomy group compared to the control group (2.21 ± 1.64 vs 4.41 ± 2.09 ; difference, -2.20 ; 95% CI, -2.73 to -1.67 ; $P < 0.001$). These improvements persisted at weeks 8 (2.49 ± 1.56 vs 4.65 ± 1.91 ; difference, -2.16 ; 95% CI, -2.65 to -1.67 ; $P < 0.001$) and 24 (3.03 ± 1.43 vs 5.07 ± 1.80 ; difference, -2.04 ; 95% CI, -2.49 to -1.59 ; $P < 0.001$). Similarly, the WOMAC function scores demonstrated significant enhancements in the acupotomy group at week 4 (11.13 ± 7.70 vs 18.10 ± 9.73 ; difference, -6.97 ; 95% CI, -9.42 to -4.52 ; $P < 0.001$), with sustained improvements noted at weeks 8 (11.38 ± 6.66 vs 18.19 ± 9.19 ; difference, -6.81 ; 95% CI, -9.06 to -4.56 ; $P < 0.001$) and 24 (12.45 ± 6.55 vs 19.79 ± 9.24 ; difference, -7.34 ; 95% CI, -9.58 to -5.10 ; $P < 0.001$). Further details on outcomes are provided in Table 2.

No patients required rescue medication in both groups during the first 8 weeks. By week 24, 6 (6.00%) patients used rescue medication in the acupotomy group and 8 (8.08%) in the control group ($P = 0.59$).

**Figure 3** Trajectory of Response Rates Over Time Between Groups. Bars show the 95% CI.

Five (5.10%) patients in the acupotomy group experienced adverse events (one occurred in week 1, one in week 2, one in week 3, and two in week 4). The most common were persistent post-treatment pain, defined as pain lasting over 24 hours and exceeding 4 on the NRS, affecting 4 (4.08%) patients. One patient (1.02%) experienced needle intolerance—manifested as severe anxiety or autonomic symptoms during manipulation—and subsequently discontinued treatment and follow-up.

Discussion

Our RCT showed that compared with diclofenac diethylamine emulgel alone, acupotomy combined with diclofenac diethylamine emulgel effectively alleviates pain, reduces stiffness, enhances functional capacity, and improves quality of life through week 24.

Our study demonstrated substantial response rates of 92.55% for acupotomy combining with diclofenac diethylamine emulgel at week 4. Another RCT that evaluated intensive acupuncture for knee OA used the identical outcome measures. That acupuncture study reported response rates of 45.0% for the electroacupuncture (EA) group and 41.4% for the manual acupuncture (MA) group at week 4. The superior response rate observed is likely attributable to the combined effects of diclofenac reducing inflammation and pain and acupotomy addressing structural issues.³⁸

A previous study evaluated the combination of acupotomy with intra-articular sodium hyaluronate for treating knee OA.³⁹ After 4 weeks of treatment, that study reported WOMAC pain scores of 2.7 ± 1.9 , stiffness scores of 1.0 ± 0.7 , and function scores of 12.2 ± 7.1 , while our study showed similar result (pain scores of 2.88 ± 2.15 , stiffness scores of 1.37 ± 1.06 , and function scores of 11.13 ± 7.70). This comparison highlights the versatility of acupotomy as a treatment option, supporting its potential as a complementary therapy alongside other treatments for knee OA.²⁵

The effectiveness of acupotomy in treating knee OA may be attributed to a combination of anti-inflammatory, neuromodulatory, and biomechanical effects. Experimental and preclinical studies suggest that acupotomy may attenuate joint inflammatory responses and cartilage catabolism, help preserve extracellular matrix integrity, and *may* modulate pain-related neurotransmitter systems in the central nervous system, thereby raising the pain threshold and reducing symptom intensity.^{21,40} In addition, acupotomy *has been reported to* release periarticular adhesions and contractures, reduce abnormal mechanical stress, and *may* improve joint mobility, with animal models suggesting favorable changes in the biomechanical properties of periarticular muscles and tendons.^{41–44}

Consistent with these mechanistic considerations, we adopted a fixed combination of local and proximal acupoints that reflects a standardized acupotomy regimen at our center. Dubi (ST35) and Neixiyan (EX-LE4) are among the most frequently used local points for knee OA and lie adjacent to the patellofemoral joint capsule and peripatellar soft tissues, making them suitable targets for releasing periarticular adhesions and reducing anterior knee pain and stiffness.^{45,46} Xiyangguan (GB33), located lateral to the knee joint, is conventionally used for lateral knee pain and tendon tightness and has been reported to influence deep periarticular tissue perfusion, supporting its use to address lateral soft-tissue tension and joint mechanics.⁴⁷ Shiqizhui (EX-B8) and Yaoyangguan (GV3) are lumbosacral points commonly indicated for low back pain and lower-limb dysfunction; their inclusion was intended to modulate the lumbosacral–lower-limb kinetic chain and neuromuscular control, thereby complementing the local periarticular effects at the knee.⁴⁸

We chose topical NSAIDs as the co-intervention for several compelling reasons. First topical NSAIDs have been proven effective for pain relief in knee OA, with a more favorable safety profile compared to oral NSAIDs. This aligns perfectly with our study's focus on providing effective and low-risk treatment options.⁴⁹ Second, the localized nature of acupotomy's therapeutic effects warrants a topical rather than systemic comparator, to allow for a more precise assessment of acupotomy's incremental benefits. Finally, diclofenac diethylamine emulgel, a widely accessible topical NSAID recommended in many authoritative OA guidelines, serves as a highly clinically relevant and appropriate control.

Acupotomy produced only mild, self-limited adverse events and no serious treatment-related complications. Although these findings indicate a favorable short-term safety profile, the sample size and single-center design limit conclusions regarding rare events, and further safety assessment in larger cohorts remains warranted.

Limitations

This trial has several limitations. Because acupotomy is an invasive procedure with characteristic tactile sensations, blinding of patients and practitioners was not feasible. This limitation may introduce expectation or performance bias. To

reduce detection bias, outcome assessment and statistical analysis were conducted by blinded personnel using standardized instruments. The single-center setting and the use of one highly experienced practitioner for all acupotomy procedures may limit the extent to which these findings can be generalized to practitioners with varying levels of expertise or to different clinical environments. Moreover, the trial population was predominantly male, which may limit the generalizability of these findings, particularly to women with knee OA. Although both groups were permitted to use loxoprofen sodium tablets as rescue medication under an identical protocol, and no significant between-group differences in usage were observed, the possibility of a modest nondifferential analgesic effect cannot be completely excluded. The high response rate in the acupotomy group should be interpreted cautiously, as it may partly reflect practitioner expertise and the characteristics of a single-center cohort. Lastly, although subjective outcomes like the NRS and WOMAC scores are validated, incorporating objective metrics in future studies could enhance the robustness of the findings.

A prior observational analysis from our group used only the baseline demographic and clinical data from this cohort to compare large-language-model-generated versus clinician-written patient education materials. No randomization procedures, treatment allocations, follow-up assessments, or clinical or safety outcomes related to acupotomy from the present RCT were included in that publication. We cite this work for transparency regarding data reuse and to clarify that the current manuscript is the first to report the randomized interventional outcomes and safety profile of acupotomy in this cohort.⁵⁰

Conclusions

Acupotomy combined with topical diclofenac, compared with topical diclofenac alone, resulted in reduced pain and improved function among patients with knee OA. Acupotomy combined with topical NSAIDs shows promise as an adjunctive, non-surgical option for knee OA management, but confirmation in multicenter, blinded trials is warranted.

Role of the Funder/Sponsor

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Abbreviations

NSAIDs, non-steroidal anti-inflammatory drugs; RCTs, randomized controlled trials; ACR, American College of Rheumatology; NRS, numerical rating scale; MCH, minimal clinically important improvement; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; ITT, Intention-To-Treat; PP, Per-Protocol; SD, standard deviation; IQR, interquartile ranges; LOCF, Last Observation Carried Forward; EA, electroacupuncture; MA, manual acupuncture.

Data Sharing Statement

Deidentified data supporting the findings of this study are available for non-commercial research purposes by academic or public health researchers who submit a sound methodological proposal. Requests can be made within one-year post-publication to the corresponding author at lishuming@bjzhongyi.com. The sharing of data will be subject to approval, and only data relevant to the proposed research will be provided.

Ethic Approval Statement

This study was conducted at the Beijing Hospital of Traditional Chinese Medicine affiliated with Capital Medical University. The study protocol was reviewed and approved by the Medical Ethical Review Committee of the Beijing Hospital of Traditional Chinese Medicine (No. 2020BL02-057-02). All procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki. The trial was registered with the Chinese Clinical Trial Registry (ChiCTR) under the registration number ChiCTR2100043005 (<https://www.chictr.org.cn/showproj.html?proj=121348>).

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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.

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Disclosure

The authors report no conflicts of interest in this work.

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